THE CATALOGUE OF SCIENTIFIC PAPERS.

Catalogue of Scientific Papers (1874-1883). Compiled by the Royal Society of London. Vol. X. (London : Clay and Sons, 1894.)

WE are glad to welcome this new volume of the Royal Society's great Catalogue. In February 1892 we noticed Vol. IX., which was the first of the three volumes that are to contain the titles of papers published in the decade 1874-83. The present volume, containing the second instalment of the material for those years, forms the tenth in the entire series of that monumental piece of bibliography for which the scientific world is indebted to the Royal Society. The section of the alphabet it includes extends from *Gis* to *Pet*, covers 1048 pages quarto, and contains considerably over 30,000 entries, giving references to the papers published in some 570 different serials. In a year or two we may hope to have the concluding portion in our hands, and our only regret is that the complete index could not have been issued within the ten years following the close of the period it covers. Such a bibliography is a work of enduring value, but it is undoubtedly most urgently needed and its services most readily appreciated in the years more immediately following the dates of the papers themselves. However, if ten or twelve years should appear an over-long interval, we must remember the magnitude of the task and the fact that the Royal Society have carried out the work single-handed. The six volumes of the first series of the Catalogue sufficed for something more than six decades (1800-1863), but for the next ten years (1864-73) two volumes were required, and now three are found necessary for 1874-83. Moreover, it is probable that the proportion of important serials which the Catalogue has *not* taken cognisance of, has gone on increasing. At any rate the Society, as we know, have now found it advisable to devote a supplementary volume (which we believe is in active preparation) to the contents of these hitherto neglected series. This want of comprehensiveness, which is, perhaps, the only blemish on this great work as it stands, is the more noticeable as the selection of serials for indexing shows traces of having been either arbitrary or dependent upon some fortuitous circumstance. Thus it may puzzle a medical writer, whose work has appeared in both, to find papers of his cited from the *New York Medical Journal*, but none from the *British Medical Journal*. But no doubt the Royal Society would be the last to claim perfection for their work, for which, as it stands, they are entitled to the highest praise. These volumes are handsomely printed, the contents are easy to consult and astonishingly free from inaccuracies of any kind. This last, their crowning excellence, is one that can be appreciated best by those who make the most use of the work. Our own experience is that for checking a series of references, to turn to the Royal Society's Catalogue is practically the same as hunting up the originals themselves, and of course vastly more expeditious. And the volumes now issuing are even more easy to consult than their predecessors; for instance, the volume numbers are now given in Arabic instead of Roman numerals—a much more legible fashion and much safer, especially in the case of high numbers. Again, the year of publication is printed in heavy type, so that this vitally important particular catches the eye at once. The abbreviations of the titles of the serials remain practically as before, and though no doubt much longer than specialists are in the habit of using in their own notes and publications, they possess the great advantage which is claimed for them—that they are "so clear as to speak for themselves." For the chemist *Ber.* may be quite sufficient, but would require interpreting to his fellow-workers in other departments of science, who would recognise at the first glance the meaning of the abbreviation adopted in the Catalogue— *Berlin Chem. Ges. Ber.* Perhaps, however, so familiar a series as the oft-quoted "Comptes Rendus" might safely admit of a shorter form than *Paris Acad. Sci. Compt. Rend.*

Altogether, anyone with any acquaintance with bibliography cannot be insensible to the enormous amount of tedious labour involved in the production of these volumes. Perhaps not more than half the entries are mere reproductions of a single title and reference, the title simply transferred as it stands from its original source to its place in the Catalogue. Many titles to make them at all intelligible have had to be amplified, in some cases they have been entirely supplied, the names of new species described are filled in, and so forth ; while a large percentage of the entries contain two or three, or even more references, to reprints, translations, abstracts, &c., which with such a mass of material implies a task of alarming magnitude in their satisfactory collation. Then there is the perplexing work of distinguishing rightly among the numerous authors bearing the same name— thus we count more than fifty Müllers, and nearly as many Meyers. There is, too, the initial difficulty which besets the compiler in the case of serials of general or technical character, of deciding which "papers" are proper to be indexed, and which should be passed over. The result, as presented in these volumes, is no doubt not an exhaustive enumeration o all the contributions in the whole body of scientific serial literature, but it is a catalogue of all the best and the most worth studying. More than this no bibliography is ever likely to be.

But withal the Catalogue of Papers furnishes but the one half of what is required. It furnishes the key to the workers, and only through them to the work. The complementary volumes, which should supply a direct key to the work, and thence to the workers, are still a desideratum. Until this also is supplied, equally systematically and comprehensively, the bibliography of science at large will remain regrettably one-sided, in spite of the numerous special *Records*, *Fortschritte*, and *Jahresberichte*. The fact of course is that a great Subject-catalogue or index is a far more difficult undertaking than the Author-catalogue to which it would run parallel. We all know the object to be aimed at—to enable the worker in science to ascertain readily what work has already been done upon his particular subject —and we are all agreed as to the desirability of attaining it. It is in the practical execution of the work that the

difficulties come in, and there they meet us in battalions. At the outset, the co-operation of working specialist and practical bibliographer is required ; but viewing the subject from different standpoints, the specialist has his ideas and the bibliographer his, and we are fortunate if we escape the familiar difficulty—*quot homines, tot sententiæ.* As to the difficulties of execution, they are, of course, primarily, how the whole system of the sciences should be divided, how far the divisions should be carried, and how the material, the particular items to be entered, should be distributed among them. For it is clear that for so vast a material no mere alphabetical index would suffice. All the contributions to one particular subject must be brought under the eye in one group, not scattered up and down through a thousand pages, according to the mere accident of the words used by the authors in their titles. The mere alphabetical arrangement attracts by its simplicity ; but in a work of this extent it would be misplaced, the entries would be lost, and the exhaustive search which would always be required would take longer than the time needed to make one's self acquainted with the scheme of classification adopted, which trouble would only need to be taken once for all. There are, moreover, important collateral advantages attaching to the preparation of practically distinct indexes for the different branches of science. Not to enlarge further on the difficulties of a Subject-catalogue—such as terminology, translation, consultation of originals, &c.—we would only say there is no royal road through all these obstacles. The path through them must always be a thorny one. Neither is there any standard of perfection, nor would it be attainable if there were. The best that can be expected is a sensible workable compromise. This is attainable, and we have little doubt will ultimately be attained, and so a key furnished to the whole series of contributions to the growth of every twig and branch of the tree of scientific knowledge from one end of the nineteenth century to the other. Since the inception of their present undertaking, the Royal Society have not ceased to occupy themselves with the question of a parallel Subject-catalogue, nor is it any wonder if the result has so long continued to be only negative. But with each decade the matter becomes more urgent, and to deal with it increased efforts are demanded, and greater sacrifices become justifiable. We believe that the Society are now on the eve of starting actual work upon the undertaking, and so commencing another monumental contribution to the "Improvement of Natural Knowledge."

EPIGENESIS.

Gestaltung und Vererbung. Eine Entwickelungsmechanik der Organismen. By Dr. Wilhelm Haacke. Pp. 337, with illustrations. (Leipzig : T. O. Weigel Nachfolger, 1893.)

WHILE it is correct to say that, as a matter of history, epigenesis implies merely the observed fact that the fertilised egg-cell, from which the new organism of each generation arises, is, under the microscope, a nucleated mass of protoplasm not differing from other cells, it is not so certain that the simplicity of the historical conception is any help to the problem as it exists for us to-day. For in the growth of an idea as it

passes from mind to mind, there is, at the best, but a formal continuity. Most often the meaning of the word has been so added to, and so taken from, that it becomes like the famous patched coat, which contained none of the original material. For the present, the question at issue is very different from the problem of those who used the word in earlier times. We know that we must not expect to see under the microscope the character of an elephant or of a mouse stamped upon the protoplasm of the fertilised egg-cell. We wish to know whether the observed facts of development and inheritance can be co-ordinated under the idea that the protoplasm of the fertilised egg-cell is as like the protoplasm of other cells as it seems ; or, under the idea of preformation, that each structure of the adult has a structural representative in the egg. But many side issues arise, and identical sets of facts really devoid of bearing upon the main question are brought forward with equal triumph by advocates of either theory. Take an example, not one that, so far as this writer knows, has been employed, but which may serve as a type. The intestine of the higher animals is very much longer than the length of their bodies, and is disposed in coils and loops. Dr. Gadow has shown that this disposition in the case of birds falls into seven or eight well-marked types which are so constant as to have high corroborative value in classification. It may well be that these varieties of twisting and coiling depend upon physical conditions, upon the relations of the growing intestine to the growth and structure of the surrounding viscera and of the skeletal tissues. Here, the advocate of epigenesis would say, are characters that need no preformation in the egg, that are stamped in due course upon its simple protoplasm. But no preformationist need suppose that the invincible elements in the germ are to grow up by their own force out of all relation to surrounding conditions. The centrifugal activities of the egg, if they exist, are there to supply those differences for which there is no cause in the outer world. They supply the factor, the resultants between which and the forces of the outer world show differences under what seem to be identical conditions.

In Dr. Haacke's book a large number of instances are brought forward in which facts of the organic world seem to be explicable by physical conditions. These are all used as arguments against preformation, and specially against Weismann and, as is the fashion just now, against the generalisations of Darwin.

Thus, under the name *Epimorphism*, he groups together a number of facts that seem to show the existence of grades and lines of development apparently independent of utility. Such are, for instance, the increase of size in organs like horns or, indeed, of whole animals ; increases which in the past history of the earth have apparently actually led to the destruction of the animals in question. Again, in most groups gradual alterations of form generally leading from regular symmetry to irregular form can be traced. Specific markings, colours and so forth, as Eimer before has showed, in many cases seem to follow in regular sequences independent of utility and adaptation. The degeneration of useless or of unused organs goes on independently of direct advantage to the animals. Geographical distribution, as Dr. Haacke showed in an interesting paper, published in 1885, reveals that for most

groups of animals a distribution of forms exists, such that the higher are found nearer the centre of the great land masses that radiate from the North Pole ; the lower towards the ends of continents and the islands reaching down into the watery waste of the southern hemisphere. This sequence of form he now explains by an interesting view. The natural selection of individuals does not depend upon their protective or adaptive qualities, but upon their good or bad constitutions. If an insect-eating bird gets upon the track of a set of caterpillars, it is unlikely to distinguish between the slight variations they may have in protective colouration. But in the struggle between race and race, the race better protected will, on the whole, attract the attention of enemies a less number of times. The selection between individuals is a selection between the generally strong and the generally weak, between those whose life-pulse beats high and those of low vitality ; not between those with an organ or an adaptation a shade weaker or stronger. The appearance of the differences between races which tend to the adaptation of some and the non-adaptation of others are due to causes independent of selection. Thus it happens that in cases where there is a wide range there are more varied local conditions, more local races, and a greater material for that competition between races which is the cause of progress. And thus where continents spread widely evolution is more rapid than in the confined areas which stretch towards the South Pole. This view is complicated by the further view that the result of crossing is not a production of variation by the mingling of characters, but an equalisation of the divergent characters of individuals.

Those who are interested in controversy will find these and a number of most interesting views and collections of facts in Dr. Haacke's book. But they are so entangled with elaborate and chiefly mathematical arguments against the views of Weismann, that they form somewhat difficult reading for the uncontroversially disposed. Moreover, they are complicated by a highly elaborate theory of Dr. Haacke's own invention. He accepts the view of Verworn that the nucleus is an organ of metabolism for the cell, and sees in the plasma with the centrosome as its organic centre, the true bearer of heredity. The plasma is composed of ultimate elements called "gemmæ." These are rhombic prisms, the ultimate shape of which is as proper to protoplasm as are the shapes of inorganic crystals to their chemical compositions. These "gemmæ" are built up into "gemmaria" by association into variously shaped layers and rods. The shape of the "gemmaria" determines the shape of the whole organism, and a number of ingenious references of symmetry to hypothetical gemmarial structures are given. The "gemmaria" of a whole organism are identical, and by a system of attractions and repulsions remain in a condition of equilibrium. But outer forces acting upon any part of the organism disturb this system of equilibrium until the organism settles down into a new position of equilibrium. As the germ cells contain gemmaria like all the gemmaria of the body, outer changes cause a new condition of equilibrium in them, and this new condition naturally is the starting-point of the new organism. The differences between individuals are chiefly differences between the degrees of closeness

in which the gemmæ of "gemmaria" are attached to each other. Those with weak attachment have weak constitutions, and in each generation are weeded out. In sexual union, the primary cause of which is the attraction between similar crystalline systems, the inequalities of attachment between the gemmæ are redressed.

It is perhaps unnecessary to add that Dr. Haacke considers that acquired characters are inherited, but that it is absurd to expect any proof of this inheritance, as, he says, the whole organic world is a proof of it, and because without it epigenesis would be impossible.

P. C. M.

AGRICULTURAL ENTOMOLOGY.

Handbook of the Destructive Insects of Victoria. (Prepared by order of the Victorian Department of Agriculture.) By C. French, F.L.S., Government Entomologist. Part II. (Melbourne : 1893.)

TWENTY notorious insect pests are dealt with in this volume, each being illustrated by a coloured plate, which shows not only the metamorphoses of the insect, but the nature of the mischief of which it is the cause. The chapter on each insect is complete in itself, and there is no definite order of treatment of subjects ; nor in a volume of this character was any such sequence called for. Arranging the insects systematically, however, it is found that the Homoptera are represented by the green peach aphis, the black peach aphis, the orange aphis, the grape louse, the cabbage aphis, the cottony-cushion scale, the oleander scale, the lemon scale, and the red scale of the orange ; the Coleoptera by the plum curculio, the cherry green beetle, the apple root-borer, and the strawberry beetle ; the Lepidoptera by the orange moth, the case-moth of the orange, the vine moth, the silver-striped vine moth, the potato moth, and the cabbage moth ; and the Neuroptera by the so-called " white ant," *Termes australis*, Hagen. With three or four exceptions, therefore, most of the insects dealt with are pests of fruit trees, and not more than half a dozen of them have acquired notoriety in England.

As the main object of the work is to supply to growers information as to the means whereby they may protect their crops against the ravages of injurious insects, we naturally look for very full information under this head, and it must be admitted that the author has admirably acquitted himself in this respect. In addition to the concise details of methods of prevention and of remedy given under the head of each pest, there is a well-illustrated appendix, containing descriptions of the various kinds of apparatus which are coming more and more into use for insecticidal purposes. Several appreciative references are made to the ingenious English-made spraying machine known as the "Strawsonizer" ; but the light knapsack modifications of this apparatus, termed the "Antipest" and "Notus" respectively, are of too recent introduction to find a place in the volume. The list of insecticide materials given in the first volume of the work is supplemented here by a further series. Moreover, as part i. contained a list of the insectivorous birds of Victoria, so part ii. contains a list of the fruit and grain eating birds of the colony. We are glad, also, to note

the many references to insectivorous insects ; for it is quite as important that a cultivator should know what insects to protect and encourage, as to recognise those which it is to his advantage to suppress. Several of the coloured plates afford illustrations of the insect foes of insect pests, and not merely of the familiar hymenopterous parasites, but of such friends to the cultivator as the species of Syrphus which devours the cabbage aphis, and of the Australian ladybird, a species of Novius, which orange-growers both in Australia and in California have found so effective an ally in keeping their groves free of the dreaded cottony-cushion scale, *Icerya Purchasi*, Maskell.

In noticing the first part of this work we appealed to the author to add to its international value by appending in every case the authority for the systematic name. We are glad that Mr. French has been able to adopt this suggestion. The agricultural entomologists of the United States are great offenders in this respect ; indeed, they sometimes give no systematic names to the injurious insects which are made the subjects of their bulletins, whilst they not infrequently coin trivial names which are certainly not elegant, though they may be expressive. Hence it becomes difficult to know with any degree of certainty what is the precise species referred to ; confusion consequently arises, and the bulletin has only a local value. In connection with the trivial names themselves, there is room for improvement. For instance, in the volume before us, descriptions are given of the " green peach aphis " and the " black peach aphis " ; but as it is the aphis and not the peach to which the colour refers, the names "peach green aphis " and " peach black aphis " would be more descriptive. This is no mere quibble, for in the volume itself the principle is conceded in the name of the " cherry green beetle." In the year 1892, when *Plutella cruciferarum*, Zell.—an insect described in this volume as the cabbage moth— wrought tremendous destruction amongst the cruciferous crops of England and Scotland, the newspapers teemed with descriptions of the ravages of the " diamond-back turnip moth." This naturally led to inquiries, perhaps ludicrous, as to the nature of diamond-back turnips ; but our Board of Agriculture set a good example by describing the pest in an official leaflet as the "turnip diamond-back moth," and thus reverting to the name by which John Curtis made the insect familiar half a century ago.

We welcome this second instalment· of a valuable publication, and trust Mr. French may be encouraged to bring to a successful conclusion a work of the highest economic importance to agriculturists and horticulturists.

OUR BOOK SHELF.

Proceedings of the Edinburgh Mathematical Society. Vol. i. Session 1883. (London : Williams and Norgate, 1894.)

FROM time to time we have noted the annual volumes of this Society from vol. ii. to vol. xi., which appeared last year. The volume before us fills up a lacuna and now makes the series complete. In the early days of the Society the publication of *Proceedings* was not contemplated, and when an access of members rendered publication possible, the cost of printing absorbed the

major part of the funds, and each session's subscriptions have only sufficed for the current session's volume. Some few years since a special appeal was made and funds sufficient to warrant publication obtained. The result is the admirable piece of geometrical work before us. For, in fact, the volume is almost entirely one man's work. The first president was Dr. J. S. Mackay, whose edition of Euclid for the Messrs. Chambers in 1884 gave ample evidence that there was an elegant and specially learned geometer in our midst. The article on " Euclid " in the *Encyclop. Britannica* confirmed this discovery. It has been long known that Dr. Mackay had large stores of notes, and we are glad to find that he has found an outlet for much of this interesting matter. At the second meeting of the Society the president read a paper on the triangle and its six scribed circles. A portion of this paper was given in abstract in vol. ii., and was considerably enlarged in vol. xi., under the heading " History of the Nine-point Circle." In the long interval, with the permission of the Council, Dr. Mackay has amassed a collection of notes, divided into twenty sections, filling more than 1600 quarto pages of manuscript. A selection has been made which most nearly corresponds with what was actually communicated to the Society in 1883. The nine-point circle is accounted for above. The sections embraced in the present instalment treat of the centroid, the circumcentre, the incentre, the excentres, the orthocentre, Euler's line, relations among the radii, and area. They occupy pp. 6–128, and are accompanied by sixty-eight lithographed figures. Each property is traced back, as far as can be ascertained, to the first discoverer, the author having had the assistance of French, German, and Belgian mathematicians in addition to the aid of personal friends in Great Britain. The result is a rich repertory of almost, if not quite, all that is known on the special points indicated above.

We sincerely hope that Dr. Mackay may be recouped for the vast amount of work he has gone through, and the expense to which he has been put, by an appreciative and purchasing audience. This will encourage him to put his remaining notes into the hands of some publisher, or possibly he may adopt the present mode of publication.

The only other paper is a collection of notes on Plücker's first equation connecting the singularities of curves, by Dr. C. G. Knott. These are printed in the form in which they were handed over to the committee eleven years ago.

The Starry Skies. By Agnes Giberne. (London : Seeley and Co., 1894.)

THIS small book will be found a very useful addition to the series in which it is published. It is written in a clear and intelligible style, and should just suit those young readers who wish to obtain some of the more elementary ideas about the world on which we dwell, the moon, and the planetary and stellar systems in general. Great tact seems to have been shown throughout in the choice of suitable examples for giving the reader a good mental grip of distances, sizes, shapes, &c., of the heavenly bodies, without over-burdening his or her mind with too much detail. The clear print and the not too liberal use of dark type render the book very pleasant reading, while the questions and answers at the conclusion of each chapter will be serviceable. The illustrations throughout are very good indeed ; the majority of them being excellent reproductions from the more or less important recent photographs. Among them we recognise Roberts' Andromeda nebula, the Pleiades, a fine Orion picture, cluster in Hercules, and several others nearly equal in quality. As a book for the young, we can heartily recommend these pages on the starry skies.   W. J. L.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

New Army Regulations.

It appears, from the letter in the daily papers of yesterday, signed by the Headmaster of Eton, that the headmasters are beginning to cry out under the smart of the rod they have made for their own backs. When, five or six years ago, Latin was made a compulsory subject for the Army Entrance Examinations, I for one, as a schoolmaster, welcomed it in that capacity, from its value as a mental discipline, and as a remedy to some extent for a certain illiterateness and incapacity for accuracy of expression, which one met with too often in Army candidates. But it was soon found that the position assigned to it was taken advantage of by men of non-scientific education, as a pretext for driving science into the background, and making it contemptible in the eyes of boys and parents, by a considerable curtailment of the time previously given to it, and then, with Egyptian logic, wondering that the marks fell off.

I do not say that the headmasters were altogether to blame for this. The spirit of the cram-shop has invaded the public schools, and is utterly spoiling their intellectual life ; and, when this spirit allies itself with other motives, the pressure may be too strong for the most noble-minded headmasters. But they, like other mortals, must reap as they sow, and accept the results of their policy. Their intellectual incapacity as a body to appreciate the value of scientific training *per se* is the fault, not so much of themselves, as of the traditions, which still hold the dominant place in this country, among those in whose hands their appointment rests. I sincerely hope that all will be done, that can be done, to minimise the mischief with regard to Latin, which is deprecated in the circular ; but I do trust that, for the public weal, the military authorities, having "put their foot down," will remain firm in insisting upon *all candidates for the scientific branches of the Army being trained, not crammed, in Experimental Science.* This they will doubtless do with their hands strengthened by the strong Committee which has been dealing with the matter in its relation to Woolwich during the last two years.

When we recollect that back in the '70's and the earlier '80's, though Latin was a *voluntary subject,* classical scholarship continued to flourish in the public schools, it is difficult to read without a smile the alarmist predictions contained in Dr. Warre's letter, as to what is likely to ensue from what he calls "the degrading of Latin from Class I., and making it a voluntary subject." The headmasters have had their opportunity, and had they, in the spirit of their intellectual ancestors of the sixteenth century, shown more magnanimity towards the "New Learning" of the nineteenth century, this rude shock to their intellectual consciousness might have been unnecessary.

Looking at the matter now from the outside, one can perhaps see the true perspective of the whole better than one could while in the thick of the fray.   A. Irving.

Hockerill Vicarage, Herts, July 6.

Erosion of the Muir Glacier, Alaska.

Dr. Wright, in his "Ice Age in North America," has calculated that the Muir Glacier erodes its bed annually to the depth of one-third of inch (p. 64). and Prof. Harry Fielding Reid, in his very interesting "Studies of the Muir Glacier" (*American National Geographical Magazine*, March 21, 1892, p. 51), arrives at the still more startling result of three-quarters of an inch per annum. As one who has paid some attention to rates of denudation by various eroding agencies, I felt some curiosity to know in what way these figures were arrived at. I find that these two calculations are substantially the same, the difference arising from Prof. Reid crediting the whole of the erosion to the glacier bed which occupies only half of the watershed of 700 square miles.

As this rate of erosion is nearly 244 times that of the glaciers of Norway descending from the Justedalsbræen, calculated from the observations of Prof. Amund Helland (*Q. J. G. S.*, 1877, vol. xxxiii. p. 158), and is altogether an abnormal and unprecedented rate of erosion of any agency we know of that acts over so large an area, I think most geologists will agree with me that

before it can be accepted we must be satisfied that the data are reliable and beyond question.

Dr. Wright unfortunately gives no particulars of the method adopted of sampling the sub-glacial waters, or the number of specimens taken, or the times and circumstances under which they were taken, all of which form material elements in the calculation. He contents himself with the bare statement that —" The amount of sediment contained in each United States gallon (231 cubic inches) of water collected from the sub-glacial streams is, as determined by the analysis of the late Prof. H. C. Foote, of Cleveland, 708·48 grains.

This proportion of sediment is nearly eighty-five times the mean of that from the sub-glacial rivers of the Norwegian glaciers descending from the snow and ice field of Justedalsbræen, and nearly twenty times the mean of the sediment from seven of the sub-glacial rivers of Greenland (*Q. J. G. S.*, 1887, p. 158), as observed and recorded by Amund Helland.

It will be seen from these bare figures that this prodigious calculation requires some explanation. It is certainly a wonderful amount of "work" to credit a glacier with that only moves 2555 feet per annum at the surface in its central position, and of course at a considerably less average rate on its bed.

The American geologists have supplied us with so much and such accurate information on many points which could not be investigated in this country, that I trust those who are able will help to correct this little sum.   T. Mellard Reade.

Park Corner, Blundellsands, June 7.

In response to the questions contained in the communication by Mr. Reade, I would say that the estimations, both of Prof. Reid and myself, concerning the erosion of the Muir Glacier are based upon a specimen of water collected by me from a large sub-glacial stream issuing from near the south-east corner of the glacier at a height of about 150 feet above tide-level. This stream is only one of many which issue from the icefront ; but it is practically the only one from which any calculations could be safely made. At two or three places where the front of the glacier is pushed out into tide water, powerful sub-glacial streams issue, boiling up at low tide with great force just in front of the ice, and discolouring the water of the inlet for miles beyond. The head of the inlet is a mile and a half wide, enlarging very soon to nearly twice that distance. The water in the middle is more than 100 fathoms deep.

The appearance and everything else indicated that the stream chosen for examination was truly representative. It was a rushing torrent from ten to fifteen yards wide, which could be waded with difficulty. The specimen was collected about the middle of August 1886, when the melting upon the surface of the glacier was proceeding at its maximum rapidity, so that the volume of water was probably much larger than the average through the year. Prof. Foote had a high reputation for accuracy, and kindly analysed the water for me, evaporating the entire amount and distilling it, so that after he had weighed the sediment the identical elements were reunited, and, as I write, it stands before me as characteristic a specimen of glacial milk as one can anywhere find.

As stated in my "Ice Age in North America" (p. 64), the estimates of erosion are based upon the supposition that the total rainfall in the drainage basin of the Muir Glacier is the same as at Sitka, namely, 100 inches, and that a certain proportion of this passes off as icebergs and in evaporation, and that the balance which is carried away by subglacial streams is properly represented by this specimen. Of course if there is any serious error in either of these data it will affect the result. But I can scarcely believe that the error can be so great as to account for all the difference between our calculations and those made concerning the erosion of glaciers in Norway and Greenland ; for the conditions are very different in the Muir Glacier from those either in Norway or in Greenland, as observed by Helland. The glaciers of Norway have a very slow movement as compared even with Prof. Reid's estimate of the movement of Muir Glacier ; while in Greenland the continental proportions of the ice and the unknown conditions of the country upon which it rests quite preclude comparison ; for it is evident that the best of the Muir glacier has a rapid gradient, while it is not certain that the best of many of the Greenland glaciers has any gradient at all. Judging from Helland's description of the appearance of the sea-water in the fiords of Greenland, I should think it was much less milky than that of the Muir inlet in Alaska.
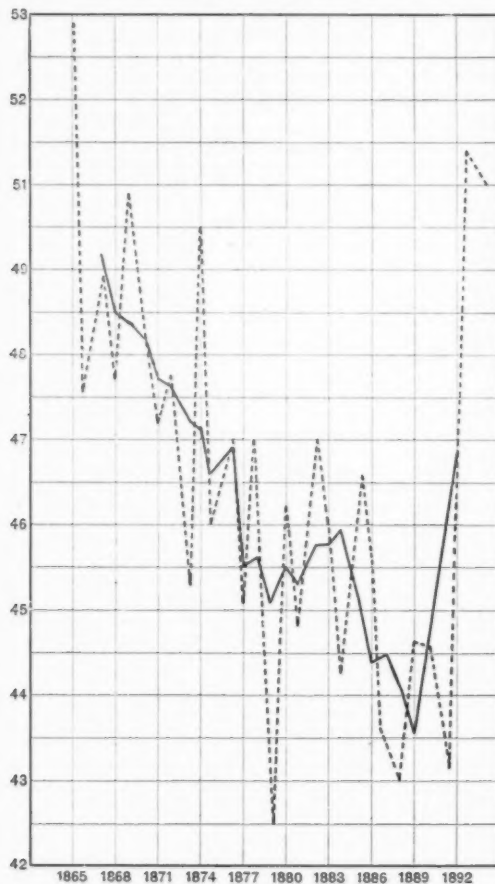
I am thankful to have had my attention called to the subject by Mr. Reade just upon the eve of departure for a few weeks among the glaciers of Umenak Bay, in Greenland. I will give special attention to the subject, and report upon my return in the autumn.   G. FREDERICK WRIGHT.

Oberlin, Ohio, June 23.

On a Recent Change in the Character of April.

THE months are all, of course, continually changing in temperature, rainfall, &c. And, as a rule, those changes are not long in one direction; the curve of variation has many zig-zags. Yet, by methods of averaging, one may sometimes detect a gradual process of change extending through a good many

1865 1868 1871 1874 1877 1880 1883 1886 1889 1892

years; we might compare it to the slope of an ocean-swell underlying the surface-ripples. The mean temperature of April at Greenwich is a noteworthy example of this.

Here are the values since 1865, and averaged in fives in a second column :—

M.T. April.	Av.	M.T. April.	Av.	M.T. April.	Av.
1865 ... 52·9	—	1875 ... 47·0	47·6	1885 ... 47·6	46·1
66 ... 48·6	—	76 ... 48·0	47·9	86 ... 46·6	45·4
67 ... 49·9	50·2	77 ... 46·1	46·5	87 ... 44·2	45·5
68 ... 48·7	49·5	78 ... 48·0	46·6	88 ... 43·5	45·1
69 ... 50·9	49·4	79 ... 43·5	46·1	89 ... 45·7	44·6
70 ... 49·2	49·2	80 ... 47·2	46·5	90 ... 45·6	45·2
71 ... 48·2	48·7	81 ... 45·8	46·3	91 ... 44·2	46·8
72 ... 48·8	48·6	82 ... 48·0	46·7	92 ... 46·9	47·8
73 ... 46·3	48·2	83 ... 47·0	46·7	93 ... 51·4	—
74 ... 50·5	48·1	84 ... 45·3	46·9	94 ... 51·0	—

Thus from a maximum of 50°·2 in 1867, the average went down, with some slight interruption at one point, to 44°·6 in 1889 (i.e. 5·6 degrees), the extreme actual values being 52°·9 in 1865 and 43°·5 in 1888 (difference 9·4 degrees). Last year and the present yield values in marked contrast to those just before, and a pronounced rise appears in the average curve.

The data for Paris and Geneva give results very similar, so that the process is not merely local. Thus the smoothed values for Geneva descend from 10°·6 C. in 1864 to 7°·9 in 1889.

A general, though less continuous, decline in the mean temperature of the entire spring (March to May), at Greenwich, may also be noticed.

I do not know whether any cause can be assigned for prolonged changes like these in April : some of your readers may be able to throw light on the matter.

The accompanying diagram illustrates the change referred to.
                                                                A. B. M.

The Deposition of Ova by. "Asterina Gibbosa."

I RECENTLY brought back from Jersey three specimens of *Asterina gibbosa*, all of which deposited ova in the small aquaria in which they were kept. As it appeared evident that the ova exuded from the oral surface, two specimens were selected for experiment.

The first was placed with the oral surface uppermost in a small glass well, with just sufficient water to cover it. When examined about half an hour later, ova had exuded from a genital pore on the oral surface, and had floated up to the top. Had the opening been on the aboral surface, they would have been retained beneath the starfish.

The second specimen was then placed in a glass dish with the aboral surface uppermost. Sufficient water was added to allow the animal to be moved easily with a pair of forceps, but not enough to enable the tube-feet to act. Consequently ova, if deposited, could not float away. In this position it was left for about an hour. When turned, so as to bring the oral surface uppermost, it was seen that ova had exuded. The starfish was killed with the eggs still adhering.

The sexes of starfish are generally said to be separate. But in this case only three specimens were brought : all deposited ova, and in one small aquarium there are now young Asterinas.
                                                                HENRY SCHERREN.

BIFILAR PENDULUM FOR MEASURING EARTH-TILTS.

INSTRUMENTS designed for measuring movements of the earth's crust belong to two classes. The first consists of seismographs which register the amplitude and period of the rapid vibrations of earthquake-shocks, and by their records enable the velocity and acceleration of an earth-particle at any instant to be determined. The second class includes nadiranes and various forms of pendulums (such as the bifilar pendulum here described) which are, or should be, unaffected by vibrations of short period, and which indicate only slow tilts or bendings of the ground, showing the change of inclination at any spot, the rate at which it is taking place, and, if periodic, the length of its period. No part of the earth, so far as we know, is free from such movements. Every day, and every year, the surface of the ground at any spot tilts forward and backward through a small angle, perhaps not exceeding a small fraction of a second. Sometimes regular pulsations are observed, each a very few seconds or minutes in duration, and lasting, it may be, for hours; at other times the tilting is irregular and occasionally abrupt; but invariably it is so slight, and takes place so slowly, that without the aid of refined instruments it could never be perceived.

The report of the Earth Tremor Committee (British Assoc. Report, 1893, pp. 291–303), presented at the last meeting of the British Association, contains an account of a new bifilar pendulum designed by Mr. Horace Darwin, and of some of the first experiments made with it at Birmingham. This preliminary trial brought to light one or two slight defects which Mr. Darwin has

endeavoured to remedy in the latest form of the instrument, of which a description is given in the present article.[1] The objects of the improvements are (1) to lessen the disturbing effects of the changes of temperature which take place in the neighbourhood of the instrument, and (2) to enable the angular value of the scale-divisions to be determined with greater ease and accuracy.

The chief novelty, both in the old and new forms of the bifilar pendulum, is the introduction of the double-suspension mirror for the purpose of magnifying the movements of the pendulum. This method was used by the Messrs. Darwin, at the suggestion of Lord Kelvin, in 1881, but it was also employed ten years earlier by M. Delaunay at the Paris Observatory.[2] In the latter case, however, the pendulum had a suspending wire 30 metres in length, and was installed in a deep pit, in which the effects of changes of temperature were so great that the successful working of the instrument was impossible.

The Double Suspension Mirror.—A small mirror, M (Fig. 1), is held in a light frame, from the upper edge of which there project two hooks or eyelet-holes, H H'. The mirror hangs by these on a fine silver wire or a silk thread, W, the ends P and P' being attached to two supports very close to one another. In the figure
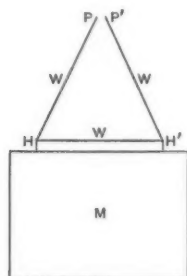

FIG. 1.

these are shown in the same horizontal line; but this is not essential. All that is necessary is that the horizontal distance between them should be small.

It is evident that the wire must always lie in a vertical plane passing through the centre of gravity of the mirror and its frame. If, then, while the point P' remains fixed, the point P be slightly displaced at right angles to the plane of the wire, it follows that the mirror must turn through the same angle as the line P P'. To take a numerical illustration, let P P' be one millimetre, and suppose the displacement of the point P to be one-thousandth of a millimetre, then the mirror will turn through an angle of 3' 26", a ray of light reflected by the mirror will turn through an angle of 6' 52", and consequently the image of the source of light upon a scale three metres distant will move through about six millimetres.

If the distance P P' be diminished, the angle through which the mirror turns for a given displacement of the point P is increased, and the arrangement becomes more sensitive. In the position of the supports shown in Fig. 1, the thickness of the wire imposes a limit to the sensitiveness that may be attained. But if one support is placed above the other, the horizontal distance between them may be made as small as desired. It will be seen that

[1] I am indebted to Mr. Darwin for notes about the changes made in his pendulum, as well as for the loan of the electros of Figs 2-4. The pendulum was made by the Cambridge Scientific Instrument Company One, of the improved form, has recently been placed in the Royal Observatory on Calton Hill, Edinburgh.
[2] C. Wolf, "Sur un appareil propre à l'étude des mouvements du sol." *Comptes Rendus*, vol. xcvii. 1883, pp. 229-230.

this arrangement is the same as that in Mr. Darwin's pendulum, and therefore, in physical investigations in which the double-suspension mirror is used, the vertical distance between the points of support should be small, otherwise the accuracy of the results may be affected by the occurrence of earth-tilts.

If the support P were rigidly connected with the end of the pointer of a delicate balance, the plane of the mirror being perpendicular to that of the beam, the delicacy of the balance will, as Dr. Poynting has shown, be greatly increased. This is, in fact, the method used by him in his recent determination of the density of the earth.[1] Or, if the support P were attached to the bob of a pendulum, the movements of the latter might be magnified many hundred times, and the most minute earth-tilts be rendered visible. Here we have in principle the apparatus employed by Messrs. G. H. and H. Darwin to investigate the lunar disturbance of gravity. Their inquiry, as is well known, did not lead to the desired result, the movements due to the action of the moon being masked by the much larger ones produced by the continual tilting of the earth's surface.[2]

The Bifilar Pendulum.—The modified form of the bifilar pendulum was designed by Mr. Horace Darwin for
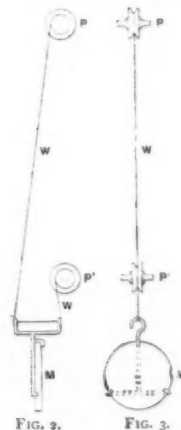

FIG. 2.　　　FIG. 3.

the special purpose of observing and recording these earth-tilts and pulsations, the points in which it chiefly differs from that used in 1881 being that the mirror itself is the bob of the pendulum, and the whole instrument is much smaller. Fig. 4 is a sketch of the complete instrument, while Figs. 2 and 3 show the manner in which the mirror is suspended.

A circular mirror, M, about 20 mm. in diameter, hangs by two small hooks on a very fine silver wire, W.[3] The ends of this wire are fixed to two points, P P', in the instrument, one of them very nearly vertically over the other. The distance between these points is about 180 mm. If the instrument be tilted about a horizontal line in the plane of the wire, the point P will be displaced relatively to P' in the direction at right angles to that plane, and the mirror will in consequence turn round a vertical axis. At a short distance from the mirror is a lamp with a translucent disc in front, and the reflection of this disc in the mirror is observed by a fixed telescope. The stand supporting the lamp and disc is moved along a scale, and the position on the scale is read when the

[1] *Phil. Trans.* 1891 A, pp. 572-574, 581-2: "The Mean Density of the Earth," pp. 78-80, 88-89.
[2] British Assoc. Report, 1881, pp. 93-126; 1882, pp. 95-119.
[3] The plane of the mirror is arranged at right angles to the plane of the suspending wire, in order that heat effects may as far as possible be eliminated. (See British Assoc. Report, 1893, pp. 300-301.)

image of a wire in front of the disc coincides with the cross-wire of the telescope. The change of readings gives the tilt of the earth's surface about a line parallel to the plane of the wires supporting the mirror. Or, keeping the source of light fixed, a continuous record can be taken on a moving piece of photographic paper, and the value of the instrument will of course be greatly increased.

If the instrument be tilted about a horizontal line at right angles to the plane of the suspending wire, the only effect is to alter the horizontal distance between the points of support, P P', and therefore to change the sensitiveness. If the tilt be about any other horizontal line, it may be resolved into two components, one about a line parallel. and the other about a line perpendicular, to the plane of the wire. The first of these deflects the mirror, the second alters the sensitiveness ; but this change of sensitiveness is nearly always very small, and may as a rule be neglected, because the displacement of P is always very small compared with the horizontal distance between P and P'. It will be obvious, however, from these remarks that the instrument is only capable of measuring tilts, or components of tilts, in one definite direction. For a complete knowledge of any given movement, it would be necessary to have a combination of two such instruments placed with the planes of their suspending wires at right angles to one another.

The body of the instrument consists of a copper tube fixed into a heavy gun-metal casting, containing a small chamber very little larger than the mirror, and covered in front by a glass window. Each end of the fine silver wire is attached to a small pulley, and the axles of the pulleys are gripped tightly so that the weight of the mirror is not sufficient to turn them. A strong copper frame carries the pulleys, and can be easily removed from the instrument, thus rendering possible the delicate operation of manipulating the silver wire. The bottom of the frame rests in a hollow cone inside the instrument just above the window ; and the length of the silver wire is adjusted by turning the copper pulleys so that the mirror hangs in the small chamber facing the window. The top of the frame is pressed by a spring against the point of a micrometer screw, and can move only in a straight line in the direction of the screw, which is at right angles to the plane of the suspending wire.

A turn of the screw thus tilts the frame of the instrument about a line parallel to the plane of the wire. Knowing the dimensions of the frame and the pitch of the screw, the tilt caused by one turn, or given fraction of a turn, of the screw can be calculated, and the corresponding change of scale-reading determined. The screw is turned through a small angle by means of a lever (Fig. 4), and adjustable screw-stops are arranged at the bottom of the lever so as to allow it to move through only that amount which will make the frame tilt through an angle of two seconds. The lever is moved by a rocking-arm turned by means of two small bellows, into which air is forced by squeezing two india-rubber balls connected with them by long tubes.

The instrument stands on three screw-feet, which are turned by two tangent-screws fixed to long rods. The ends of these rods are shown in Fig. 4. The tangent-screws are arranged so that turning one will tilt the instrument about an axis parallel to the plane of the suspending wire, and will therefore move the spot of light sideways, so that, when it has nearly left the photographic paper, it is easily brought back to the

required position without approaching the instrument. Turning the other screw tilts the instrument about an axis perpendicular to the plane of the suspending wire, and this alters the sensitiveness.

When the ends of the silver wire have been fixed to the pulleys, and the frame, to which the latter are attached, has been inserted in the instrument, the copper tube is completely filled with paraffin oil. If the frame is tilted, the mirror then comes to rest very slowly, and rapid
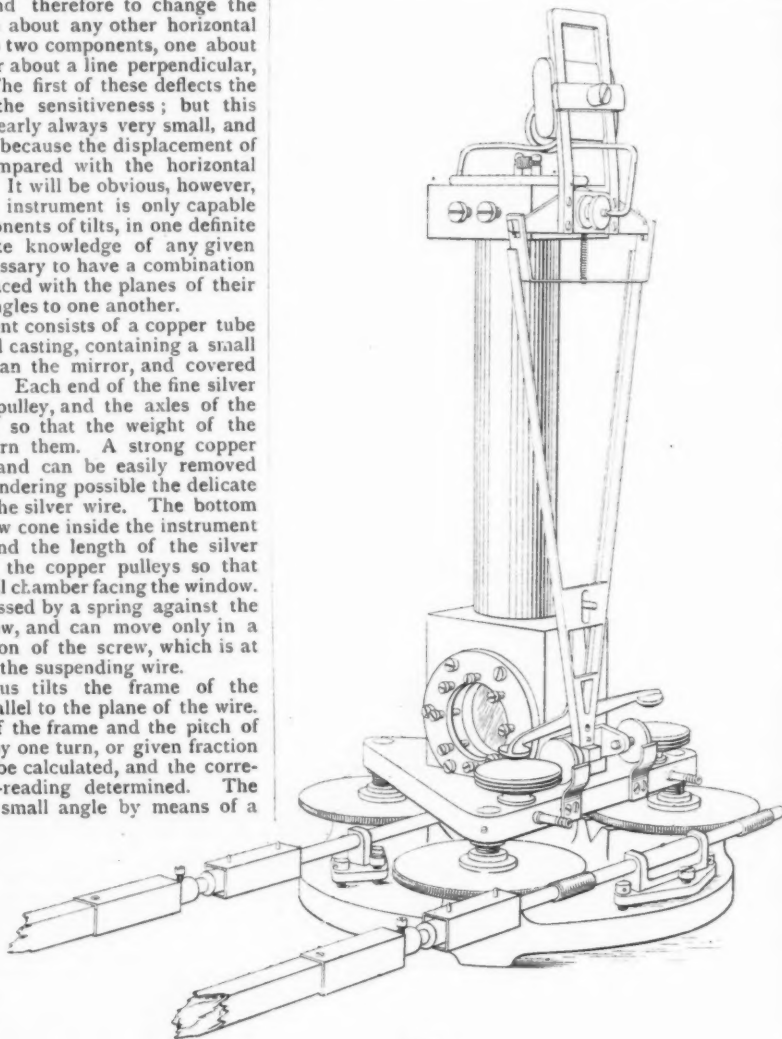

F IG. 4.

vibrations, like those caused by passing carts and trains, do not affect it. Thus the pendulum is designed, not so much for the study of earthquakes, as for the investigation of slow tilts and pulsations of the earth's crust, by whatever cause they may be produced.

Delicacy and Uses of the Bifilar Pendulum.—In the pendulum with which the preliminary experiments were made at Birmingham, the vertical distance between the points of support of the silver wire is one foot, while the horizontal distance between them is about $\frac{1}{250}$ of an

inch. If the instrument be tilted through an angle of one second about a line parallel to the plane of the suspending wire the mirror turns through an angle of 49′, and the magnifying power of the instrument is therefore very nearly 3000. A scale is placed at a distance of ten feet, and 3·44 inches of this scale correspond to a tilt of one second. If the lamp be displaced by $\frac{1}{100}$ of an inch, the movement can be clearly perceived. It follows, therefore, that it is possible to observe with this pendulum a tilt of less than $\frac{1}{300}$ of a second, an angle less than that subtended by a line an inch long placed at a distance of a thousand miles.

It would seem, then, that the bifilar pendulum is admirably adapted for measuring the minute changes of level, which are perhaps the cause of some of the uneliminated errors in many astronomical and physical inquiries. Indeed, it may be hoped that the time is not far distant when a pendulum of this kind will be regarded as a part of the ordinary equipment of every great observatory. Again, the bendings of the earth's crust by changes of barometric pressure,[1] by the ebb and flow of the tides, &c., may be studied, as well as the long-period pulsations produced by violent earthquakes in almost any part of the world. It is not too much to expect, also, that in time we may be able to trace out and measure the slow secular movements of the earth's crust which, after the lapse of ages, become perceptible to the geologist ; and that the vexed question of the origin of lake-basins may receive an answer that will remove this most debatable of subjects from the domain of controversy for ever.   C. DAVISON.

THE SPECTRUM OF OXYGEN IN HIGH TEMPERATURES.[2]

AT a previous meeting, I brought before the Academy a method, founded on the use of electricity, of bringing gases under pressure to a high temperature without heating sensibly the recipients which contain them.

Before rendering an account of the experiments already made on oxygen by means of this method, I shall mention first those which have preceded them, and in which temperatures not exceeding 300° have been realised by means of a line of gas jets playing directly on the tube containing the oxygen.

The arrangement was as follows :—A steel tube ten metres long, lined inside with red copper, and closed at its extremities by glass, according to our ordinary modes of closing, was placed in a trough containing a sand-bath. This trough was immediately warmed by a line of a hundred gas jets. The temperature of the tube was taken by means of thermometers metallically connected to the tube.

After having introduced the oxygen at the required pressure, and before the heating of the tube has begun, a good spectrum of a luminous light source is obtained, the beam being thrown along the tube in such a way that any change in the spectrum brought about by heating the gas is perceptible.

When the jets are lighted, the spectrum changes in proportion, as the temperature increases at the same time as the pressure. If the experiment is well conducted, the the pressure of the gas at the end, that is to say, when lights have been extinguished and the temperature has become what it was at first, returns to its original value. To obtain this result there must be no loss of gas during the experiment.

This loss of gas is caused principally by the lengthening of the pins that unite the pieces of steel which hold the glasses at the extremities of the tube. In order

to prevent this lengthening, bands of brass have been placed between the heads of the pins and the disk, the length of which has been calculated to compensate by their expansion that of the pins. Thus the same degree of pressure is obtained at all temperatures.

The experiments have been made with varied pressures of oxygen. They show that from the ordinary temperature up to about 300° the bands and lines of the spectrum of absorption of oxygen do not undergo modification.

But quite a new feature is produced. A remarkable point is the very remarkable augmentation of transparency of the gaseous column with the increase of heat, a transparency revealed by a considerable augmentation of the brightness and the limits of the spectrum, above all on the side of the red. I shall have to return to the theoretical consequences of this important fact.

To ascend further in the scale of temperatures, it is necessary to make use of the platinum spiral tube rendered incandescent by the passage of the current.

I will not repeat the general arrangement of the experiment already described. The incandescence of the
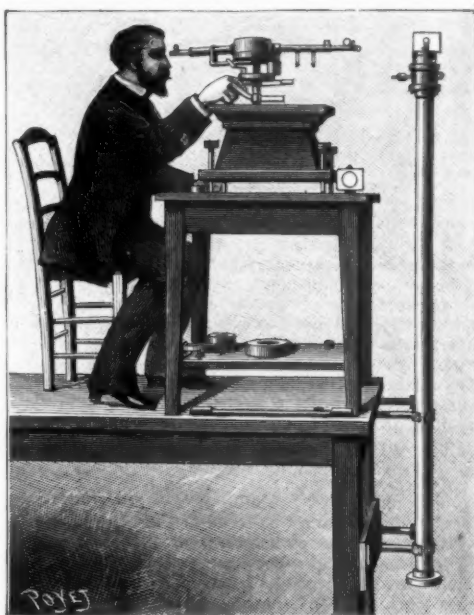

FIG. 1.—Experiments with a vertical tube and incandescent spiral.

spiral is more difficult to obtain if the pressure of the gas is greater.

The temperature to which the spiral is carried can be determined in different ways :—(1) The thermo-electric couple ; (2) the observation of the increase of the pressure of the gas caused by the passage of the current ; (3) and finally, the brightness and length of the spectrum given by the incandescent spiral, when it furnishes the light alone.

The experiment works thus :—

The tube being placed in a vertical position, the lamp, which must produce the beam to be analysed after its passage in the tube, is first regulated, and then the spectrum analysing apparatus is arranged. Pressure is then put on, and the constitution of the spectrum having been well observed, a current is made to pass, the power of which is proportional to the temperature which has to be obtained.

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[1] Such observations would gather additional interest if made in the neighbourhood of a great line of fault.
[2] A communication made by Dr. Janssen to the Paris Academy of Sciences. Translated from *La Nature*.

The pressure increases immediately, and stops when equilibrium is established. The spectroscopic phenomena are always followed and compared at the beginning and when equilibrium is established.
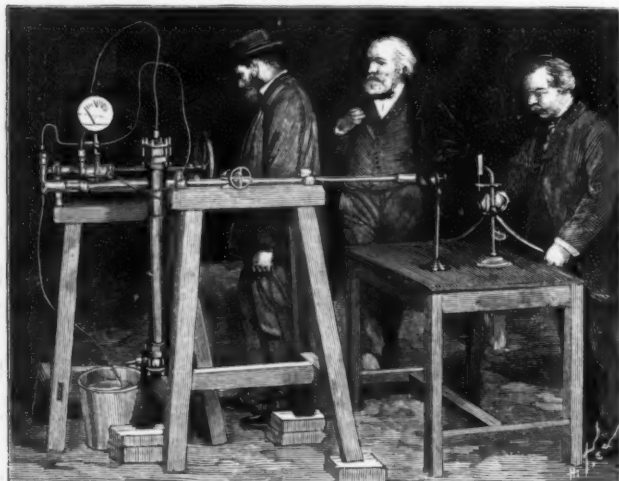

Fig. 2.—Apparatus for experiments at high pressure.

In the experiments made with the tube of two metres in length, and with gaseous pressures up to 100 atmosphere, perceptible modifications in the length of the spectrum observed have not been noted. The attained temperatures have been estimated between 800° and 900°, according to the spectrum given by the spiral.

To obtain higher temperatures it is necessary to increase the power of the electric generators, and that is what it is proposed to do; but it must be observed that the solar phenomenon point of view, it is the exterior and middle parts of the coronal atmosphere which interest us most. It is those which, if they contain oxygen, would, above all the others, produce steam, by reason of their lower temperatures. But temperatures of 800° and 900°, which have already been realised, correspond to the deep parts of the coronal atmosphere, and in these, as well as in those which are more exterior, and consequently colder, the absence of oxygen may be affirmed.

PHOTOGRAPH OF A LANDSCAPE IN LIVING AND DEAD BACTERIA.

A FILM of living bacteria in Agar was distributed over very thin (cover-slip) glass sterilised; this thin glass alone separated the film from the negative. After exposure over a mirror for two hours, and then forty-eight hours' incubation, the bacteria behind the transparent parts of the negative were killed; those behind the opaque parts developed normally; those partly protected were retarded, giving the half tones. The photograph was sharper when first made, several weeks before reproduction.

NOTES.

LORD KELVIN has been awarded the Grande Médaille of the Société d'Encouragement pour l'Industrie Nationale of Paris, for his scientific works. Among other awards we note the following : 3000 francs to M. Dulac for a means of diminishing smoke at industrial centres; 1000 rancs to MM. Fuchs and de Launay for their work "Gîtes Minéraux"; and 500 francs to M. Chapel for his "Caoutchouc et la Gutta-Percha"; 2000 francs to Prof. Roberts-Austen for his work on alloys (see NATURE, June 7); 1500 francs to M. Pagnoul; and 500 francs to the Société d'Agriculture in the Meaux district, for investigations on the comparative physical nature and chemical constitution of the soils of certain regions.

AFTER a long illness the Right Hon. Sir Henry Layard passed away on July 5, at the age of seventy-seven. His excavations at Nineveh and Babylon, and his travels through various parts of Asia, have made his name eminent among archæological investigators and discoverers.

WE regret to record the death at Paris of M. Mallard, the Professor of Mineralogy in the Ecole Nationale Supérieure des Mines.

THE *Times* correspondent at Calcutta telegraphs that, since the beginning of the rainy season, the water in the Gohna Lake has been rising about two feet daily, and is now 160 feet from the top of the dam. As percolation has begun through the dam, and is increasing with the increased pressure, it is thought that the overflow will probably not occur before the middle of September.

A REUTER telegram from St. John's, dated July 7, states that the Peary Auxiliary Expedition has sailed on board the steamer *Falcon* for Inglefield Gulf, Greenland, to bring home Lieut. Peary's party. They will call at Carey Island, where

the Swedish naturalists Bjorling and Kallstenius were wrecked in the schooner *Ripple* in 1892, and will also search at Cape Faraday and Clarence Head to ascertain the fate of the

naturalists. The party will explore Jones's Sound and make a chart of the coast, returning to Bowdoin Bay for Lieut. Peary on September 1. The expedition is expected to return by September 20. Dr. Ohlin, the Swedish zoologist, and Messrs. Chamberlain and Libbey, represent the scientific side of the party, which is under the leadership of Mr. Bryant.

DR. M. A. VEEDER informs us that the Jackson-Harmsworth Polar Expedition, which starts from London to-day (see p. 255) for an extended sojourn in the Arctic regions, will co-operate in observation of the aurora upon the concerted plan which is in use by a large number of observers in various parts of the earth, and by the expeditions of Lieut. Peary and Dr. Nansen. This, together with what has already been done, insures the continuance and perfecting of these observations, which are having results that promise to be of great practical value both to astronomical and meteorological science, as well as to the study of physics in general.

AT the last meeting of the Physical Society it was announced that in future the meetings of the Society will be held in the rooms of the Chemical Society, Burlington House. Since its foundation in 1874 the Society has met in the Physical Lecture Theatre of the Royal College of Science.

VIOLENT earthquake disturbances were experienced in Constantinople on Tuesday afternoon. The first shock occurred shortly after noon, and is said to have lasted twenty seconds. Another wave was felt at four o'clock. In both cases the direction of motion appears to have been from east to west. About the same time, a severe earthquake was also felt at Smyrna and Scio, and in the Dardanelles.

MISS ORMEROD, writing to the *Times* of Saturday last, mentions that bad attacks of the grass-destroying caterpillars of the antler moth are now occurring in some localities in Scotland. She says that in 1884 these caterpillars devastated an area of about ten miles in extent of the mountainous parts of Glamorganshire, and in 1885 spread over an area of about seven by five miles in Selkirkshire, N.B. The district infested at present is that in which the voles not long ago did so much damage, and Prof. Wallace reports that the caterpillars are doing even more mischief than the voles.

THUNDERSTORMS again occurred in nearly all parts of Great Britain on the 6th inst., and were reported at places during several subsequent days ; the disturbance appears to have been caused by a shallow barometric depression advancing northwards from the south-west of France. The thunderstorms were again preceded by abnormally high temperatures, especially over the eastern and southern parts of England, where the thermometer rose above 85°, while at Rochefort, in France, the maximum temperature in the shade rose to 99° on the 5th. Some very heavy falls of rain have also been reported, the total in two days amounting to about three inches in the south-west of Ireland, and quantities of considerably over an inch in twenty-four hours fell in Scotland and the south of England. The average rainfall since the beginning of the year has now been about reached, or exceeded, in all districts except the midland parts of England ; in Scotland the average has been exceeded by about five inches.

AT a Council meeting of the Pharmaceutical Society of Great Britain, last week, Mr. Martindale moved the following resolution :—"That after the first day of January, 1895, a practical knowledge of the metric system of weights and measures shall be required of all candidates for the Minor examination in the subjects of prescriptions and practical dispensing, and that the Board of Examiners be instructed to require from candidates a general knowledge of posology in terms of the metric as well

as the British system of weights and measures as defined by the British Pharmacopœia, 1885 ; and in practical dispensing 'to weigh, measure, and compound medicines' by the metric as well as the British system of weights and measures." After some discussion the resolution was altered to the effect that the Board of Examiners should be requested to consider the advisability of acquiring a practical knowledge of the metric system of weights and measures for the Minor examination. In this form it was carried.

WE regret to note that the recently issued report of the Council of the Marine Biological Association states that there is no immediate prospect of a satisfactory boat being obtained by the Association : the question is purely a financial one, and its solution is only to be found in the generosity of public companies or private individuals. The Council points out that it is impossible that a sea-going boat can be purchased out of income, so long as the revenue of the Association is so small. During the past year the work of collection has been largely carried out by means of hired vessels, a method both expensive and unsatisfactory. As to scientific investigations, we read that, during the past year, both Mr. Cunningham and Mr. Holt continued their inquiries into the various questions relating to the maturity of food-fish which were so prominent last year before the House of Commons Select Committee on Sea Fisheries, and upon which much information is still required. More important, perhaps, is the fact that Mr. Cunningham has finally settled by direct experiment the much-debated question of the identity of the egg of the pilchard. He has been able to rear the larvæ of plaice, hatched and fertilised in the aquarium at Plymouth, to the age of thirty-seven days ; no flat-fish larvæ had previously been reared in confinement from the ovum to this age, and the result is of great economic value.

THE German Fisheries Association offers prizes of 800, 1000, and 600 marks, respectively, for the best works on the following subjects :—(1) Simple, trustworthy, and generally applicable methods for the determination of the gases oxygen, carbonic acid, and nitrogen found in natural waters, or at least of the first two, special importance being attached to methods independent of the higher resources of the chemical laboratory. Competitors to send in before June 1, 1895. (2) Investigations concerning the pathological and anatomical effects upon fishes of the following bodies found in drain-waters :—Free acids, free bases, especially lime, ammonia, soda, and the soluble carbonates of potash and soda ; free bleaching gases, such as chlorine and sulphurous acid. Further, the determination of the symptoms of suffocation from these causes. Partial and even negative answers are not excluded. Representatives of the Salmonidæ and Cyprinidæ families are recommended for investigation. Papers to be sent in before November 1, 1896. (3) The development and conditions of life of the water fungus *Leptomitus lacteus*, and its appearance and disappearance in polluted waters. Papers to be sent in before November 1, 1895. All papers for the competition are to be sent in registered envelopes to the General Secretary, Prof. Dr. Weigelt, Berlin, S.W., Zimmerstrasse 90, 91. They may be written in German, French, or English, and are to be provided with a motto and with the name and address of the author in a sealed envelope bearing the same motto. The object of the Association is to throw light on the pollution of natural waters by animal and industrial refuse. The withdrawal of the gases mentioned, which have an intimate relation to the amount of putrifying matter, is difficult to prove. The symptoms of death due to pollution by free acids and other poisons are not as yet very well known. Sugar and starch factories send drain-waters into the rivers, which offer ample sustenance to the white river algæ, especially *Leptomitus lacteus*. These may be regarded as having a purifying effect, but the de-

composition of the dead floating masses gives rise to further pollution. An examination of the habits of this plant appears, therefore, highly desirable in the interests of the inland fisheries. The judges are Drs. Fleischer, König, Tiemann, Hermann, Nitsche, Virchow, Hulwa, Kirchner, Magnus, and Weigelt.

AN investigation by Prof. W. J. Sollas, F.R.S., "On the Relation of the Granite to the Gabbro of Barnavave, Carlingford" (*Trans*. Royal Irish Academy, vol. xxx. part xii. 1894), has added facts of considerable importance to what was previously known about the mountain groups of Carlingford and Slieve Gullion, which rise from the centre of the Palæozoic tract of the counties of Lough and Armagh, and represent the remains of extinct volcanoes of the Tertiary period. From an examination of the district, and a study of rock-sections from it, the following statements are deduced :—(1) The gabbro of the Carlingford district is older than the granite which penetrates it. (2) The gabbro was already completely solid, traversed by contraction joints, and, probably, fractured by earth movements before the injection of granophyric material. (3) The granophyric material was in a state of great fluidity at the time of its intrusion. The granophyric dykes are in no case contemporary veins. The results of the investigation suggest to Prof. Sollas some reflections on the difficult question of the "differentiation of originally homogeneous igneous magmas." In his opinion, "much more attention must be given to the investigation of the details of the now prevalent differentiation hypothesis before it can be regarded as established on a firm basis." In fact, the importance of this paper as a contribution to physical geology is liable to be overlooked, owing to the topographical nature of its title; but it soon becomes apparent to the reader that the close intermingling of rocks of different composition which has taken place at Barnavave, is not likely to be an exceptional occurrence. The proofs of microscopic penetration of the gabbro by the granite, until a bulk-analysis of any specimen would be most misleading, are interesting to all geologists, and practically open a new field of observation. A severe blow is struck at the whole theory of "segregation veins," or "contemporary veins," which has perhaps been maintained too academically and without complete confirmation in natural exposures. It is worth noting that this memoir is issued separately by the Royal Irish Academy, like all published in their *Transactions*.

IN a paper published in the *Electrotechnische Zeitschrift*, in which he described a new form of gas voltameter, Prof. Kohlrausch expressed his surprise that the gas voltameter was so seldom used for measuring currents. The reason for this state of affairs is probably to be found in that the form of gas voltameter ordinarily in use is both inaccurate and troublesome to use. A new form of gas voltameter has recently been devised by Herr H. A. Naber, of Amsterdam, which embodies several improvements. The burette in which the gas evolved (either hydrogen or oxygen) is collected, can be turned about a vertical axis so as to bring its lower end over the electrode, and thus start or stop the collection of gas at any given time without breaking the current passing through the voltameter. By means of an auxiliary vessel into which air can be driven, the level of the liquid inside and outside the burette can be made the same, so that there is no correction to be applied to the barometric pressure in order to find the pressure under which the gas is measured. The burette is fitted with a tap, so that the oxygen or hydrogen evolved can be passed into another vessel and collected. The whole of the apparatus is constructed of glass, except, of course, the electrodes, which are of platinum, and are so arranged that the two gases evolved can never possibly mix, and thus cause an explosion, if by any chance the platinum of the electrodes becomes exposed to this mixture of gases.

A NEW form of automatic steering compass has been invented by Lieut. Bersier, of the French Navy, and a very full description is published in *La Nature* for June 25. The difficulty with any form of automatic compass is that any arrangement by which the compass card makes or breaks a mechanical contact when the course deviates from a straight line will interfere with the free set of the needle. Lieut. Bersier, in his compass, uses a spark from a Ruhmkorff coil, which passes between a metal point on the edge of the compass card and one of two semi-circular metal plates fixed to and insulated from the sides of the compass bowl. These metal plates are connected to two small electromagnets, and when the electric current which forms the spark passes, it closes the circuit of a small motor which actuates the steering gear. If the spark passes to one plate the motor works in one direction, while if the spark passes to the other plate the motor works in the reverse direction ; so that it is only when the point on the card is half-way between the two metal plates that the rudder is amidships. It is said that the new compass has been tried in the French Navy for several months past, and has given entire satisfaction, which, considering the very delicate and complicated nature of the mechanism employed, is very remarkable. The new form of compass can be made to automatically register the course steered, the spark being caused to pierce a band of paper which is moved by clockwork.

IN a short paper communicated to the Johns Hopkins University *Circular*, Mr. A. S. Mackenzie describes some experiments he has conducted to test the validity of the Newtonian law of attraction for crystalline and isotropic masses at small distances. In discussing the elastic solid theory of refraction in physical optics, it is often customary to introduce an optical density which may be different in different directions. In uniaxal crystals there are two such directions, and in the case of Iceland spar the square roots of the densities are as $1\cdot486$ to $1\cdot658$. Thus the question arises, does this property depend upon the distribution of the mass with reference to the optic axis? and if so, could a crystal attract a particle in a manner dependent upon the position of the particle with reference to the optic axes of the crystal, so that it would act as if it were of greater mass (and therefore density) in one direction than in another? It is to elucidate this point that the author has been conducting a series of experiments, using for this purpose a form of apparatus which, at any rate as far as the magnitude and suspension of the attracted masses are concerned, resembles that used by Prof. Boys. The apparatus, however, is designed for relative rather than absolute measurements. Although the greatest divergence between any two results only amounted to 1 part in 200, no difference in the attraction of a crystalline mass along, and at right angles to, the axis was discovered. A second set of experiments was undertaken in which the attracting masses were isotropic, but in which the distances between the attracting and attracted masses was varied, with a view of testing the law of the inverse square of the distance. The form of apparatus used seems particularly ill-suited to test this point, as the distances between the centres of the masses are very hard to measure. The author, however, says these distances could be measured to within $\frac{1}{10}$ mm , and he finds that while the deflections as calculated, assuming the correctness of the inverse square law for distances of about $7\cdot4$, $5\cdot5$ and $3\cdot6$ cm. between the centres of the large and small masses were as $1 : 2\cdot05 : 5\cdot25$, while the observed deflections were as $1 : 2\cdot04 : 5\cdot24$. So that the Newtonian law has been found to be true for the attractions of non-isotropic, and for isotropic masses at distances apart as small as 3 or 4 cm.

IN the *Modern Medicine and Bacteriological Review* for May, attention is called to a subject which is attracting special in-

terest just now amongst bacteriologists—the existence of sub-varieties of microbes of specific species. We have frequently referred in these notes, directly and indirectly, to the poly-morphism exhibited by one and the same variety of micro-organism when submitted to different conditions of environment, &c., whilst Prof. Percy Frankland has repeatedly shown how the power of fermenting various solutions may not only be imparted to par-ticular microbes by suitable training, but also removed from them. M. Péré has recently shown that there exist many sub-varieties of the bacillus *coli communis*, and Dr. Sanarelli has demon-strated the same in a series of investigations, conducted under Prof. Metchnikoff, for the typhoid bacillus, whilst the list of pseudo and other cholera vibrios is fast becoming unmanage-able. The desirability of a due recognition of the fickleness of microbes to prescribed forms, &c., in the diagnosis of disease, where the bacteriological evidence is regarded of first import-ance, is obvious to all ; whilst at the same time it is but one of the difficulties which a larger horizon has placed in the path of the bewildered bacteriologist. The other microbial notes are mainly on subjects already reviewed in these columns, whilst the medical articles are too technical to admit of reference here.

AN interesting account of hereditary malformation of the hands and feet is contributed by Drs. W. Ramsay Smith and J. Stewart Norwell to the *British Medical Journal*. In the subjects examined, the malformations in the hands affected the middle and ring fingers. These fingers were webbed to the tips, and the bones were disposed in an extraordinary manner. For instance, on the left hand the tip of the middle finger looked as if it were twisted in front of the ring finger, while the nails, which in the right hand were in the same plane, formed in the left a well-marked angle with one another. Each foot of the subjects had six toes. The second and third toes were webbed almost to the first interphalangeal joints, and the first and sixth toes up to the nail, while the fourth toe was comparatively free. It is not so much the striking abnormalities that are interesting, however, as the persistency and consistency with which the mal-formation has affected several generations. Taking back the history of the case as far as they could investigate it, the authors found that twenty-one out of twenty-eight of the family were malformed. An important point in this record is that mal-formation of the hands was always associated with malformation of the feet. In no instance was there a malformation of the hands alone or of the feet alone ; and the malformation, as far as could be ascertained, showed very little variation. Another point is that it seemed to go very much in the female line. It is also remarkable that the wife of one of the subjects had been married previously, and had borne three children by her first husband, nevertheless all the children of the second husband inherited the malformation possessed by him.

MESSRS. BLACKIE AND SON have published the third part of Prof. F. W. Oliver's translation of Prof. Kerner's "Natural History of Plants."

MESSRS. WILLIAMS AND NORGATE have issued a list of new scientific works published in German, French, and other foreign languages. The list is No. 59 of their scientific series of foreign book circulars.

WE have received an advance copy of the eleventh annual report presented to the Chemical Section of the American Association for the Advancement of Science, by the Committee on indexing chemical literature. The report consists of a descriptive list of bibliographies published during last year.

Some very interesting reminiscences of the late Rev. Leonard Blomefield, together with a portrait of him, are given by Mr. H. H. Winwood in the *Proceedings* of the Bath Natural History

and Antiquarian Field Club (vol. iii. No. 1). Mr. Blomefield was the founder of the Club, in 1855, and took the warmest interest in its work up to the time of his death in September last.

PART ii. of volume lvii. of the *Journal* of the Royal Statistical Society has just been published. Mr. Charles Booth's paper, "Statistics of Pauperism in Old Age," and the discussion on it, as submitted at the meeting of the Society in March, is con-tained in this number. The paper forms the first part of a volume since published by Messrs. Macmillan. Two other papers are included in the *Journal*, viz. "Conditions and Prospects of Popular Education in India," by Mr. J. A. Baines, and "Modes of Census-Taking in the British Dominions," by Mr. R. H. Hooker.

WE stated some time ago that the United States Hydro-graphic Office was collecting information with the view of publishing a monthly Pilot Chart of the North Pacific Ocean. The first chart, for the month of July, has now been issued, and contains, among other useful information, data showing the calms and prevailing winds, the currents, and mean isobars drawn for Greenwich noon, for that month. The chart is at present far from complete, because of the limited number of observations in unfrequented portions of the ocean ; nevertheless it is a good beginning, and no doubt the appeal made to observers to co-operate in the work will eventually enable the hydrographer to fill in the details where they are now wanting.

EVERY student of physics knows Deschanel's "Natural Philo-sophy," by Prof. J. D. Everett, F.R.S. For many years this treatise, and that by Ganot, have been the standard works for classes in elementary physics, and the thirteenth edition, just published by Messrs. Blackie and Son, will enable this position to be maintained for some time to come. It is well known that the work is not merely a translation ; in fact, Deschanel's "Traité de Physique" only forms a basis upon which Prof. Everett has constructed an invaluable text-book. So many are the addi-tions to the new edition that three pages of the volume are taken up with the enumeration of them. The work has been entirely recast, much of the old matter has been rearranged, and new matter has been largely introduced. Part II. contains a new chapter on Thermodynamics, in which free use is made of the methods of the Differential Calculus. An explanation of en-tropy, Dewar's experiments, and Van der Waal's theory with respect to the departure of gases from Boyle's law, are among the many additions to this part. Two new chapters have been added to Part III. (Electricity and Magnetism), and much of the antiquated matter has been omitted. Very extensive changes have also been made in the optical portion of Part IV., and a new chapter has been introduced dealing with systems of co-axal lenses. These judicious revisions and expansions have resulted in the production of a work which bears the same relation to physics of to-day that the original treatise did to the state of physical knowledge at the time of publication. The work may, therefore, be expected to be just as successful in the future as it has been in the past.

THE nature of the explosive decomposition of the ammo-nium and mercury salts of diazoimide, N_3H, forms the subject of a communication to the *Annales de Chimie et de Physique*, by MM. Berthelot and Vieille. The ammonium salt, N_3NH_4, was obtained in large, brilliant, transparent crystals by the method of Curtius, the action of ammonia upon diazohip-puramide suspended in alcohol and recrystallisation from water. The crystals may be handled without much danger of explosion if due care is taken. They sublime at the ordinary temperature *in vacuo*. The pressure produced during their explosion has been determined in a small steel cylinder provided with piston and registering apparatus ; a similar cylinder of copper was

burst by the violence of the explosion. The pressure produced was found to be equal to that of one of the gunpowders recently tested by M. Berthelot, but the combustion appears to be a relatively slow one ; the temperature of deflagration is about 1350°-1400°. Hence the ammonium salt of diazoimide is a remarkable explosive on account both of the force developed during explosion and of its low temperature of deflagration. The products of the decomposition are ammonia, hydrogen and nitrogen. The ammonia was actually liquefied in the cylinder. The temperature is not sufficiently high to dissociate ammonia, so that there is first a decomposition into ammonia and diazoimide and then a subsequent decomposition of the latter into its elements. This probably accounts for the extreme force of the explosion, the energy which would otherwise have been absorbed in effecting the dissociation of the ammonia being available in the explosion. The mercurous salt of diazoimide, N_6Hg_2, was obtained by precipitating a dilute aqueous solution of the ammonium salt with mercurous nitrate. The precipitate requires very careful washing and drying, owing to its highly explosive character. Its explosive decomposition is extremely rapid, analogous to that of fulminate of mercury, and the temperature of deflagration high, about 2700°. The mercuric salt, N_6Hg, may be conveniently obtained from the mercurous salt by decomposing it with sulphuric acid, and treating the solution of diazoimide thus prepared with freshly precipitated yellow mercuric oxide. The greater portion of the salt separates as a white precipitate, but it is somewhat soluble in cold water, and very considerably soluble in hot water, from which long acicular crystals are deposited on cooling. It is the most dangerously explosive of the salts investigated, and the experiments have unfortunately had to be abandoned on account of serious accidents to M. Berthelot's assistants. It is much more sensitive and therefore more dangerous than fulminate of mercury, and explodes when least expected and in a most violent manner. It furnishes the same volume of gaseous products of decomposition as fulminate of mercury.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. Conrad W. Cooke ; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Wheeler ; a Cheetah (*Cynælurus jubatus*) from Somali-land, presented by Mr. William Mure ; four Hedgehogs (*Erinaceus europæus*), British, presented by Mr. F. C. Smith ; two Senegal Touracous (*Corythaix persa*) from West Africa, presented by Miss E. B. Redwar ; a —— Falcon (*Falco*, sp. inc.) captured at sea, presented by Mr. Arthur L. Sclater ; four —— Anolises (*Anolis*, sp. inc.) from North America, presented by the Southern Curio Company ; a Crowned Lemur (*Lemur coronatus*) from Madagascar, three —— Opossums (*Didelphys*, sp. inc.) from South America, deposited ; two Obsolete Tinamous (*Crypturus obsoletus*) from Brazil ; a Smooth Snake (*Coronella lævis*) from Austria, purchased ; three Indian Cobras (*Naia tripudians*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF THE ORION NEBULA.—Two papers on the spectrum of the nebula in Orion are contained in the current number of *Astronomy and Astro-Physics*, one by Prof. J. E. Keeler, and the other by Prof. W. W. Campbell. The former observer photographed the spectrum of the nebula many times during last winter. A comparison of the photographic and visual observations of nebular lines, with dark lines in the spectra of the Orion stars, indicates that an intimate relation exists between the two. "Indeed," says Prof. Keeler, "taking into account the relative intensities of the lines, the spectrum of Rigel may almost be regarded as the nebular spectrum reversed." Spectroscopists will remember that Dr. Huggins obtained an anomalous spectrum of the Orion nebula in 1889, his photo-

graph showing a large number of fine lines apparently connected with the spectra of the trapezium stars, while the hydrogen lines H_δ and H_ϵ were absent. Prof. Keeler has tried to obtain the same result by photographing the spectrum in the same way as Dr. Huggins, but without success. He shows that "contrary to the belief which has been held up to the present time, the trapezium stars have spectra marked by strong absorption bands ; they have not the direct connection with the nebula that would be indicated by a bright-line spectrum, but are in fact on precisely the same footing (spectroscopically) as other stars in the constellation of Orion. While their relation to the nebula is more certain than ever, they can no longer be regarded as necessarily situated *in* the nebula, but within indefinite limits they may be placed anywhere in the line of sight." Finally, with regard to the appearances that have led to the belief that the nebular lines are bright in these stars, Prof. Keeler believes that they are of physiological and photographic origin, and do not actually exist. It is pointed out that these conclusions have an important bearing on theories of stellar development.

Prof. Campbell's paper, which is continued from the May number, deals with the spectrum of the Orion nebula and other well-known nebulæ. In it Prof. Campbell brings together all his spectroscopic observations of nebulæ. Like Prof. Keeler, he was unable to confirm Dr. Huggins' observation of the absence of certain hydrogen lines in the spectrum of the Orion nebula. His photographs also show that the spectra of the trapezium stars all conform to the Orion type, and contain numerous dark lines, but no bright lines. By tabulating the observations published up to the date of the paper, it is shown that of the twenty-five bright lines known to exist in the spectrum of the Orion nebula, at least nineteen are definitely matched by dark lines in the Orion stars, and at least fifteen by dark lines in the six faint stars situated in the dense parts of the nebula. Including his own observations, Prof. Campbell finds that thirty-six bright lines have been observed in the spectra of the seven nebulæ examined by him. He has tabulated all the lines that have had their positions determined either from photographs or by direct observation.

THE NEBULOUS CHARACTER OF NOVA AURIGÆ.—The question of the telescopic appearance of Nova Aurigæ is again brought up in *Astronomische Nachrichten*, No. 3238. Prof. E. E. Barnard, at the end of a communication on micrometrical observations of the object, made with the 36-inch telescope of the Lick Observatory, says that when he examined the star on August 19, 1892, it appeared to be densely nebulous, and that since then it has not appreciably changed. He has made a very careful examination of the star in order to test whether the nebulosity was due to instrumental defects or not, and the result of his investigation is the conclusion that—"When the Nova is in the best possible focus it is hazy and surrounded for 5″ or 6″ with a decided nebulosity. . . . How much of this nebulosity is due to the peculiarity of the spectrum of the Nova, I am not able to tell. But from my experience with nebulæ I would unhesitatingly say that the Nova is distinctly and unquestionably nebulous." This testimony, coming from such an experienced observer as Prof. Barnard, is very important. An inspection of the micrometrical observations made at the Lick Observatory, failed to show any marked periodic variation of the star's position, such as might be due to parallax. The object must therefore be at an enormous distance from us.

A series of observations of the relative position of Nova Aurigæ and a comparison star of magnitude 10·2, is also communicated to the same number of the *Astronomische Nachrichten* by F. Renz, of the Pulkowa Observatory. The observations extend from September 1892 to March 1894. The series shows no perceptible variation in the relative positions of the two stars. As regards the suspected nebulosity, Dr. Renz found that it disappeared on pulling out the eyepiece by about 3·6 mm., thus indicating that the nebular appearance was due to a want of definition produced by the different refrangibility of the light emitted by the Nova. He thinks that the object has never appeared so nebulous as it was in September 1892, and he suggests that this may be accounted for by the fact that the hydrogen line at λ 486 $\mu\mu$ (F) and that at λ 495 $\mu\mu$ have diminished in intensity.

THE APIS PERIOD OF THE ANCIENT EGYPTIANS.—The Apis Period of the ancient Egyptians formed the subject of a recent paper read before the Vienna Academy by Dr. E. Mahler. The author showed that this 25-year period could no

be related to the duration of life of an Apis, since many different periods are recorded for that. But by reducing the dates of the enthronement of Apis as given by Brugsch and Lepsius in the Egyptian reckoning to the Julian chronology on the basis of the fixed Sirius year, the significant fact was discovered that such enthronement always took place on the day of the full moon. Since Apis is known to be the visible representation of Osiris, and the latter is identified with the full moon, it is reasonable to suppose that the Apis-period of $9125 = 25 \times 365$ days was purely astronomical, and that the name was derived from its connection with the full moon and Osiris.

OBSERVATIONS OF THE PLANET MARS.—A telegram transmitted by Prof. Pickering to Prof. Krueger, and printed in *Astr. Nach.* No. 3241, reads as follows :—"Holden telegraphs : Bright projection of Mars terminator like that previously observed at Lick Observatory and seen several mornings, best seen June 28 near Polar Cap, Ganges seen double."

THE JACKSON-HARMSWORTH POLAR EXPEDITION.

THE private Polar Expedition led by Mr. F. G. Jackson, and financed by Mr. A. C. Harmsworth, sails from the Thames to-day, July 12, on board the steam-whaler *Windward*, for Franz Josef Land, calling *en route* at Archangel.

Many of the equipments of the expedition were exhibited to a select party at an "at home" given by Mr. and Mrs. Harmsworth at the Grafton Galleries on Friday evening, and on Monday last a number of visitors were shown over the ship in the Shadwell Basin, when the special arrangements for the expedition were more fully explained.

The staff which has been finally selected by Mr. Jackson to accompany him on his projected land journey in the far north includes the following :—Mr. Albert Armitage, second in command, a young officer of the P. and O. Company's service, who is a practical navigator and trained in astronomical and magnetic observations; Dr. Kettlits, medical officer; Captain Schlosshauer, a merchant skipper; Mr. Fisher, curator of the Nottingham Museum, as scientific collector; Mr. Burgess, who has had some previous Arctic experience, and will act as cook; Mr. Childs, who undertakes mineralogical work and photography; and Mr. Dunsford, who, like Mr. Jackson and Mr. Armitage, has a knowledge of surveying. Some friends of the explorers sail with the party, intending to return from Archangel.

Several previous expeditions have acquired some knowledge of the natural conditions of Franz Josef Land, and it is confidently expected that game, in the shape of bears, seals, and birds, will be abundant. Accordingly a complete outfit of sporting guns, rifles, harpoons, &c., is being taken. The expedition is, however, fully provisioned for four years with the most highly condensed and thoroughly preserved foods obtainable. Much reliance is placed on the fresh bear and seal meat, expected to be shot, for the prevention of scurvy, but Mr. Jackson also proposes to use port wine as a specific. The use of alcohol and tobacco, which has recently been entirely discarded in Arctic work, is one of the peculiar and probably not unpopular features of the present attempt on the Pole.

The arrangements for travelling include boats for crossing open water. One of aluminium, measuring 18 feet by 5 feet, weighs only 150 lbs., and can carry twenty people; it is made in three sections for convenience of transport on sledges, and each section will float by itself. A similar copper boat, weighing about 200 lbs., is also carried, and three light wooden Norwegian boats. A fast steam-launch, appropriately named the *Markham*, is expected to be of service if it is found possible to proceed from the base for some distance by sea, or up Austria Sound.

Eighteen sledges of exceptionally light and strong construction, each calculated to carry 1000 lbs. weight if necessary, are taken; these are to be drawn by Siberian dogs or ponies. There are three collapsible tents, and suits of Samoyed clothing for use in winter, the cumbrous-looking garb of these Siberian nomads being considered better adapted for rough work in bad weather than the tighter-fitting costume of the Eskimo pattern. The scientific instruments carried are perhaps the finest that have ever been taken into the far north, the extensive use of aluminium ensuring a lightness and strength never before attained in Arctic exploration.

After landing the exploring party in Franz Josef Land about the end of August, the *Windward* will return to England, if possible, and sail again next year with fresh supplies.

The whole cost of the expedition is estimated at £25,000.

ANNUAL REPORT OF THE PARIS OBSERVATORY.

ON the 3rd of March of this year, M. Tisserand presented his report to the Council of the Observatory regarding the state of the Observatory during the past year. In his preliminary remarks he refers briefly to the work in course of execution. Under the direction of Le Verrier, great attention was concentrated on the meridian service, which comprises observations of the sun, moon, planets, asteroids, and the revision of the catalogue of Lalande. Extra-meridian observations of comets and small planets have been made with the equatorial in the west tower, and M. Wolf has been occupied in astro-physic researches. An important work in hand is that of publishing a catalogue of the Observatory, based on all the values of the meridian observations made from 1837-1881, while special researches on the R.A. of fundamental stars have been undertaken, and on the declinations, after methods proposed by M. Lœwy. The equatorial service has been enlarged by the addition of another coudé, which instrument is devoted to the observation of planets, comets, systematic measures of double stars and nebulæ, and will be occupied in future with the study of the most interesting variable stars.

With regard to the work in hand, M. Tisserand says that there is enough "assuré pour plusiers années." In remarking on the great preponderance of meridian work, he refers to its considerable importance in astronomy, furnishing as it does the constants for calculating the positions of planets and stars. Photography, he says, gives the means of determining exactly the positions of small stars on a cliché with relation to a certain number—say a dozen—of reference stars; but the positions of these last-mentioned ought to be measured by meridian instruments.

The movement relative to the lengthening of the railroad has been making great headway, and already the means of protection suggested by the Council have been commenced, notably that of the *mur d'isolement* constructed near the tunnel.

Let us take a rapid survey of the work done with each of the separate instruments as reported by the head of each department.

Large Meridian Circle.—Besides general transits observed, it was attempted to correct the catalogue of polar distances of fundamental stars, in continuing zenith distance measures of stars with the adopted latitude. A series of sixty stars, six times observed, showed that the corrections agreed very satisfactorily among themselves, and harmonised well with those furnished by the normal catalogue of M. Auwers.

Simultaneous observations have also been made to correct the ephemerides of the *Connaissance des Temps* and the latitude, while active researches have been started for finding out the causes of the inequalities. With reference to the "flexion horizontale," the instrument has remained firm, the mean value given by the collimators being $-0''\cdot68$, those for the three preceding years being $-0''\cdot54$, $-0''\cdot73$, and $-0''\cdot66$.

Meridian Instrument, Gambey.—The work started in May 1890, of correcting catalogue R.A.'s of fundamental stars, has been continued, and the corrections found are "faibles et bien concordantes," as shown from the following few values :—

Stars.		1890. s.	1891. s.	1892. s.
θ Virginis	...	+0·03	+0·03	+0·02
25 Canes Venatici	...	−0·03	−0·12	−0·14
m Virginis	...	+0·07	+0·06	+0·03
T Virginis	...	+0·09	+0·06	+0·04
Arcturus	...	+0·07	+0·05	+0·04

Circle of Gambey.—Employed exclusively for researches on the variation of latitude; 127 nadir distances of polaris were measured, of which 101 were direct, and 26 by reflection.

Cercle Méridien du Jardin.—During the earlier months this instrument was used for the determination of polar distances of fundamental stars and for latitude, by methods of M. Lœwy. A minute determination of the inclination of the horizontal thread of the instrument was also made, and also the influence of personal equations in the cases of stars near the pole, M.

Renan having installed in front of the eyepiece a prism which reversed the direction of apparent movement of the stars, either in right ascension or declination.

The "Supplément á l'Histoire Céleste de Lalande" is undergoing revision, and the positions of 2250 stars are required to be re-observed, each three times by meridian observations. Since April 1893, sixty series, comprising about 1000 stars of the catalogue, have been obtained.

The *résumé* of the meridian observations made during the year shows that the instruments were by no means idle, no less than 17,248 observations having been made. The *résumé* of the planets observed during the same period gives the total number as 556.

Equatoriaux Coudés.—The large equatorial has been receiving several alterations and additions, and it is hoped to maintain the position of a fixed or movable star on the same part of a photographic plate with an approximation of $0''\cdot 2$ nearly. The small coudé has been the means of effecting the complete measurements of 186 double stars, besides some observations of minor planets, comets, occultations, &c.

The Equatorial in the West Tower.—This instrument is under the direction of M. Bigourdan, who, with M. Faye, were away observing the total eclipse of the sun at Sénégal. During their stay there, fifteen lunar culminations for longitude and four series of observations for latitude were made, besides meteorological observations and four independent determinations of the relative intensity of gravity. The solar observations, among other things, consisted in observing the four contacts, and searching round the limb of the sun for any small bodies that might be visible.

The observations made with the equatorial above referred to consisted of measurements of 280 double stars, besides those of comets, occultations, &c.

The equatorial in the east tower, under M. Callandreau's direction, has been devoted chiefly to observations of minor planets.

In the departments where photography is employed, MM. Henry have obtained, among other results, 169 clichés for the catalogue of the *Carte du Ciel*, twenty-nine large clichés of the moon, enlarged directly eighteen times, these latter marking "un progrès très sensible sur les résultats obtenus antérieurement."

The "Bureau des Mesures des Clichés du Catalogue," under Mdlle. Klumpke's supervision, is now supplied with two machines. The total number of stars measured in the twelve months amount to 27,750; of these 26,831 were measures of stars, 343 measures of double stars, and 32 planetary measures.

The meteorological observations and the hour service have been regularly continued, the latter without any failure during the entire year.

In the spectroscopic department, M. Deslandres has been continuing the researches on the sun and stars; but much time was devoted to the preparations for the observations of the total eclipse of the sun last year. The results obtained during the eclipse consisted of twenty-two photographs of the corona. Some of the negatives show luminous jets from the corona extending to a distance of two diameters. The ultra-violet spectrum of the corona has been traced up to the limit of the ordinary solar spectrum, and in addition fifteen lines have been observed in the new region. In the researches concerning the rotation of the corona, it has been found that one of the negatives shows the spectra of two points of the corona, situated at the extremity of an equatorial diameter and 10' from the solar limb, placed side by side. The bright H and K lines of calcium present a slight displacement corresponding to a difference of velocity of 5 to 7·5 kilometres. M. Deslandres admits that the solar corona is animated with a motion of rotation, the angular velocity of which corresponds with that of the sun.

Other spectroscopic work being continued is that of the study of the radial velocities of prominences and stars.

THE CHEMISTRY OF CLEANING.[1]

AS a great city grows, and the agglomeration of struggling humanity increases, such questions as the disposal of sewage and other waste matter rise from comparative insignificance into problems of almost insurmountable difficulty; and

[1] A lecture delivered at the London Institution, by Prof. Vivian Lewes.

whilst we are able to put the burden of cleansing our towns upon the urban authorities, the responsibility of keeping our homes and bodies in a condition of at least sanitary cleanliness devolves upon the individual, and a knowledge of the causes of dirt and the methods by which it can be removed, cannot be regarded as devoid of interest, or at any rate utility.

Before we can cleanse, we must have dirt to remove, and this prime factor of our subject naturally must claim our first attention.

Dirt has been variously defined : a great statesman has spoken of it as "matter out of place," poets have christened it the "bloom of ages," whilst more matter-of-fact individuals have been content to look upon it as something which causes an infinite amount of trouble in the household, and leads to the consumption of much soap and water. If, however, we divest our mind of prejudice, and approach the subject of dirt from a scientific point of view, we shall find a silver lining to the grimy cloud, and shall have to admit that a wondrous store of interest is to be found in the dust with which the housemaid wages perpetual war, and which when glued by nature to our skins, requires special methods for its removal.

Observation shows that in our town houses, only a very short interval of time is needed to cause a considerable deposit of dust upon any horizontal surface, whilst vertical surfaces and draperies, especially if their surface be rough, also accumulate a considerable quantity, although of a lighter and more finely divided kind. We also find that this dust is borne to its resting place by the air which penetrates from the outer atmosphere, and that its deposition is caused by the comparative condition of rest insured to it by the absence of wind or violent currents.

The presence of these air-borne particles of solid matter can be made visible in any town by allowing a beam of sunlight or a ray from an electric lantern to pass through the air of a darkened room. If the room be filled with air previously filtered by passing it through cotton wool, the beam of light is invisible until it strikes the opposite wall ; but if the air be unfiltered, the path of the beam is mapped out by the suspended matter reflecting and dispersing portions of it, and so becoming visible to the eye as "the motes in the sunbeam."

The heavier the nature of the particles, the more quickly will they settle, with the result that the dust on horizontal surfaces, such as the tops of sideboard, piano, and mantel-board, may be expected to differ somewhat from the lighter form, which has continued to float until contact with vertical surfaces has brought it to rest.

These particles of dust are composed of matters of the most varied nature, and will be found, when collected, to consist partly of mineral and partly of organic substances, namely, siliceous and carbonaceous matters, hair, epidermis from the skin, pieces of vegetable fibre, pollen from various plants and grasses, the sporidiæ of fungi and bacteria.

The heavier portions of the dust are found to contain ground-up siliceous matter, pulverised by traffic in the road ; small particles of salt carried inland by winds from the sea, together with sulphate of soda, with other impurities of a local character. If a sample of dust be collected and carefully ignited, the organic matter will be burnt away, and any ammonium salts volatilised, whilst the mineral portion will be unacted upon ; and in this way it has been shown that more than one half of the suspended matters in the air are of organic origin, a large portion of this organic matter consisting of germs which are capable of setting up fermentation, disease, and decay.

It is only within the last few years that the importance of the work done by the solid particles of dust floating in the air has been recognised, and it is to Pasteur that we owe the knowledge that these germs set up the various processes of organic decay.

Pasteur collected the lightest portions of dust, which are left floating in the air after the heavier portions have settled down, by gently drawing air through a plug of soluble collodion cotton ; and after he had collected sufficient dust in this way, he dissolved the cotton in a mixture of alcohol and ether, and examining the residual particles under the microscope, was able to show the presence of a large and variable number of organisms obtained from the atmosphere.

He also found that solutions of sugar mixed with beer yeast, and left exposed to the air, rapidly decomposed. If, however, the solution was kept in contact with air, that had been previously heated, it would remain unchanged for months, but de-

composition was started in a few hours if some of the germs collected from the air were added to it.

If a pot of ordinary paste, after being used, is placed on a shelf for a few days, the surface will be found coated with a fine crop of mould or mildew. On examining this mould under the microscope, it will be seen to somewhat resemble a bed of rushes ; after a few more days, some of these rush-like filaments will have developed little pods, not unlike poppy-heads, and after the lapse of another week the pods will have split open, and myriads of seeds or germs will have poured forth into the air to carry on nature's cleansing work, for these germs possess the power of setting up the process of decay, by which the waste matter derived from vegetable sources is once again resolved into the water vapour and carbon dioxide used by nature as the foundation of all organic creations.

Decay and putrefaction are the great factors of change which nature utilises for removing the waste products of animal and vegetable life, and for once more bringing them into a condition in which living things can again assimilate, and use them for building up their tissues and carrying on their functions. Without decay, the dead animal and vegetable matter would remain choking the face of nature, and life would be impossible, because the food of life would be cut off ; and it is the almost imperceptible germs floating in the air which start this marvellous natural action, germs so minute that it requires the strongest microscope to detect them, yet so potent that the whole balance of life hangs on their existence.

These facts show us that not only has dust a most marvellous history, but that in it nature has disguised her most important factor for cleaning the face of the earth from waste matter of both mineral and vegetable origin.

The surface soil when mixed with water gives the mud which dirties our boots, and forms clots on the train of our skirts ; but this, as well as the dust which has settled in our living rooms, and merely clings mechanically to the surfaces upon which it has deposited, may be removed by such simple physical means as the duster and brush. When dust has found its way into a fabric such as a carpet, it requires considerable force to again dislodge it, and this is applied by means of the broom, but in vigorous sweeping we find that the largest proportion of the dust is driven up into the air, only to resettle once again on other surfaces, so that although we can make the nuisance "move on," we do not in this way remove it, and experience has taught our servants that wet tea-leaves scattered on the carpet before sweeping lessen this evil In some cases, instead of using this method, it has been argued that it must be the moisture which acts in preventing the raising of the dust, and the carpet has been sprinkled with water. This converts the dust into mud, which remains fixed in the fabric whilst the sweeping is going on, but as soon as the water has evaporated from it, again reasserts its right of rising as dust.

When, however, wet tea-leaves, damp sawdust, or even moistened sand is scattered over the surface to be swept, the dust when dislodged adheres to the moistened substance and is removed. In choosing moist bodies for this purpose, the only points to consider are that they must have no staining action on the carpet, must not be too wet, and must not be so finely grained as to sink into the fabric, nor so clinging as to resist easy removal by the broom.

It is manifest, however, that the mechanically held dirt which we have been considering, differs very considerably from the dirt on our skins, and on linen in contact with our bodies, which although derived from the same sources as the dust on the furniture, resists any ordinary mechanical process for its removal, and rinsing dirty hands or linen in cold water has but little cleaning effect, whilst if the hands are afterwards dried in the usual way, a transfer of a portion of dirt to the towel takes place.

If we carefully notice the portions of our skin and shirt which become most soiled, we at once observe that it is where the skin is exposed to air, whilst the linen, which is in contact with both air and skin, becomes dirty more quickly than when exposed to either alone.

The part played by the atmosphere is made clear by the facts which we have already been considering, but the action of the skin introduces a new and most important factor. For the healthy carrying on of the functions of life, nothing exceeds in importance the skin with which our body is covered. We may live for days without giving our stomach any work to do, the liver may cease action for several days before death ensues,

but it is impossible to survive for the same length of time if the functions of the skin are entirely stopped.

The skin not only plays an important part in throwing off and getting rid of waste matter from the system, but it is also credited with being an important auxiliary to our lungs, and experiments have clearly shown that if the skin of animals be coated in such a way as to completely stop its action, a very few hours will bring about death. Indeed the experiment has been once accidentally tried on a human being, a child gilded all over to represent a statue having died in a few hours ; all the symptoms pointing to suffocation as being the cause of death.

If we examine the structure of the skin, we find that it is built up of two distinct layers, an outer skin called the cuticle or epidermis, and an inner termed the cutis or dermis. A third layer intermediate between these two, used to be looked upon as a third skin, but more recently has been recognised as being only a transition form of the outer skin.

The cuticle or outer skin consists of several fine layers of scales which gradually assume a more rounded and granular form the deeper one gets into the cuticle. These rounded granules form the middle skin of the old observers, and as the outer portion of the cuticle roughens and scales off as scurf, these granules gradually flatten and form the new surface to the outer skin, and we differ therefore from other scaly reptiles by being continually in a condition of renewing our skin, whilst most reptiles and fish cast their scaly covering in on operation.

No nerves or blood-vessels find their way into this outer skin, as may be seen when it becomes detached from the inner skin in the formation of a blister, the outer portion of which is devoid of sensation.

The lower or true skin varies in thickness, being thicker in the palm of the hand and sole of the foot, where most resistance is needed.

When we look at the skin of the hand, we notice delicate grooves in it, which examined through a magnifying glass are seen to be pierced with small orifices, and if the hand be warm, minute shining drops of perspiration will be seen issuing from them.

The glands for the secretion of the perspiration are set in the lower side of the inner skin, and are in connection with the capillary network of blood-vessels, which cover the surface of the body. The gland or duct which conducts the perspiration to the surface of the skin is about a quarter of an inch in length, and is straight in the true skin, but becomes spiral whilst traversing the outer skin. Over 3500 of these small ducts have been found to exist in a single square inch of the skin, and it has been computed that the aggregate length of the sudoriferous ducts in the body of an ordinary-sized man is about twenty-eight miles.

These little glands and ducts perform the important function of throwing off the moisture produced during the combustion of waste tissue, by the blood-borne oxygen of the body, and secrete about 23 ounces of perspiration in the twenty-four hours, which under ordinary conditions evaporates, without our noticing it, into the air, but under conditions of considerable exertion or unusual heat, accumulates as beads of perspiration.

The throwing off of the perspiration and its evaporation on the skin, is a beautiful natural contrivance for regulating the temperature of the body, as the conversion of the perspiration into vapour renders latent an enormous amount of heat, which being principally derived from the body keeps it in a comparative state of coolness, even when subjected to high temperatures.

That this is so, is proved by the fact that a bath heated to 120° F. (=49° C.) is almost unbearable, because the evaporation from the surface of the skin is checked, whilst it is perfectly possible for a person with the skin fully exposed to go into an oven and remain there for some time at a temperature of 325° F. or 162°·8 C., at which temperature a beef-steak can be cooked, and it can be clearly noticed in a Turkish bath, that although there is a feeling of oppression at first, the temperature of the hot room can readily be borne as soon as perspiration begins to flow.

In the 23 ounces of liquid so secreted in the course of the twenty-four hours, there will be found rather more than an ounce of solid matter, which is left when the liquid portion of the perspiration evaporates, and tends to clog the pores of the skin, and it is the removal of this by the morning tub and

rough towel, which is responsible for a considerable portion of the refreshing influence of the British bath.

Besides these sudoriferous glands, however, there is a second set, called the sebaceous glands, the ducts of which are spiral, and open generally into little pits, out of which the fine hairs which stud the skin grow, and these glands secrete an oily or waxy substance, which nourishes the hair, and also keeps the outer skin smooth and pliant. This waxy substance is developed in largest quantity inside the ear, where it serves to protect the more delicate portions of that organ, and next to the ear, these glands are found most abundantly on the face and other portions of the body which are exposed to external influences and friction.

It is the presence of this oily secretion which holds the dirt glued to the skin, and being also rubbed off on the inside of the wristbands and collars of our shirts, causes these portions of our linen to become the most soiled. We may look upon this form of dirt, therefore, as being glued on to the surface by oleaginous materials, which being insoluble in water resist any mere rinsing, and the most important function of our cleansing materials is to provide a solvent which shall be able to loosen the oil, and so allow of the removal of dirt from the skin.

The skin, however, is not the only source of oily matter, and in all fibres of animal origin more or less fat is to be found, which although not in sufficient quantity to play any very important part in the fixation of dirt, still adds its iota to the general result.

We notice, moreover, that the air of a big town has a far greater dirtying effect than country air, this being partly due to the fact that the number of solid particles per cubic foot of atmosphere are greatly reduced, but chiefly because country air does not contain certain products of incomplete combustion, which are to be found in all large towns.

In London we annually consume some six million tons of bituminous coals, and if we examine the smoke which escapes up our chimney during the imperfect combustion which the coals undergo in our fire-grates, we find that not only will that smoke contain small particles of unconsumed carbon in the form of blacks or soot, but also a considerable quantity of the vapour of condensible hydrocarbon oils, which depositing on the surface of the solid particles of floating dirt, gives them an enhanced power of clinging to any surface with which they come in contact.

If we have a heavy fall of snow in London, as the snow melts it leaves a black deposit, which is formed of the solid particles with which the snow has come in contact in its passage through the air, and a recent analysis of a deposit of this character, collected on the glass roof of an orchid house at Chelsea, gives a very good idea of the constituents of these solid impurities.

Carbon	.	.	.	.	39·00 per cent.	
Hydrocarbons	.	.	.	12·30	,,	
Organic bases	.	.	.	1·20	,,	
Sulphuric acid	.	.	.	4·33	,,	
Hydrochloric acid	.	.	.	1·33	,,	
Ammonia	.	.	.	1·37	,,	
Metallic iron and magnetic oxide	.	2·63	,,			
Other mineral matter, chiefly silica and ferric oxide	.	.	.	31·24	,,	
Water	.	.	.	.	not determined.	

Hydrocarbon oils of this character are not as a rule affected by the solvents which we utilise for loosening the dirt which is held to our skin by animal grease; but there is no doubt that the dirtying influence of town air is greatly increased by their presence.

If we take any grease of vegetable or animal origin, we find that it can be dissolved in liquids containing free alkalies, this term being applied to the compounds formed by water with the soluble metallic oxides, which, when dissolved in water, give solutions having a soap-like taste, affecting the colour of vegetable extracts, such as that obtained by the red cabbage, and possessing the power of neutralising the acidulous properties of the compounds we call acids.

If we take two metals discovered by Sir Humphrey Davy in 1807, potassium and sodium, and expose them to dry pure air, they rapidly become converted into a white powder by absorbing oxygen from the atmosphere, and form compounds which we term respectively oxide of sodium and oxide of potassium. These oxides, when dissolved in water, enter into combination

with a portion of it, producing sodic hydrate and potassic hydrate, two substances which have pre-eminently the properties which we term alkaline, and which exert a strong solvent action upon all forms of animal and vegetable grease.

These solutions exercise a wonderful power of cleansing upon the grease-bound particles of dirt which veil our skin, but so strong is their solvent power upon animal membrane, that not only do they dissolve fatty matter, but also the cuticle itself, so that they are manifestly unfitted for removing dirt from a tender skin, and we are forced to look further afield for a grease solvent.

If instead of dissolving our sodic and potassic oxide in water, we had left them exposed to ordinary air, we should have found that they gradually attracted from the atmosphere a gas called carbon dioxide, which exists in all air to the extent of 4 parts in 10,000, and that by combining with this gas they became converted into sodic and potassic carbonates, bodies which we call salts, and which, although not so violent in their action upon the skin, will retain to a certain extent their solvent action on fatty matters.

The carbonates of sodium and potassium are found in the ashes of many vegetable and animal substances, and in the earliest records which have been discovered, we find mention of the cleansing power of wood ashes, the ashes of certain marine plants, sea-weed, and "natron," which is an alkaline efflorescence from some kinds of soil; nor has the use of ashes for this purpose entirely died out at the present time.

It was only in 1884, that during some structural alterations in Rome, an old tomb was broken into, and the ashes which it contained removed by one of the workmen, who conveyed them home to his wife, as an offering towards the next washing-day, whilst a few days later the antiquarians were horrified to discover that they were the remains of the Emperor Galba, cremated some eighteen centuries before, which had been put to such practical use.

As early as A.D. 69, however, we find that the elder Pliny mentions another form of cleansing material made from tallow and ashes, the components most recommended being goat's suet and the ash of beechwood; whilst the ruins of Pompeii were found to contain a fairly perfect soap factory.

Although soap and Christianity date from the same period, it was only at the commencement of this century that the classical researches of Chevreul on the constitution of fats, gave the key to the reactions taking place during its formation, whilst even at the present time we probably only know a true explanation of part of the actions which lead to its cleansing effect upon the skin.

If we take sulphuric acid diluted with water, we find that it has certain well-marked characteristics, which leave no room for doubting its acidulous nature, and if we pour a few drops of it into the violet-coloured solution obtained by boiling sliced red cabbage in water, the violet solution at once becomes bright red. On repeating this experiment with the violet cabbage solution, and a few drops of sodic hydrate solution, we obtain a vivid green colour, and now on mixing the solution rendered red by the acid, and the second one turned green by the alkaline base, we once more obtain the original violet colour, and on examining the solution can find no trace of either acid or alkali, but can distinguish the presence of a compound called sodic sulphate, which can be obtained in the crystalline form by concentrating the solution, and such a compound formed by the union of an acid and a base, we are in the habit of calling a salt. During the combination of the sulphuric acid and sodic hydrate to form sodic sulphate, we also had water being formed, which, like the neutral salt, had no action upon our coloured solution. If we had carefully weighed our sulphuric acid and the sodic hydrate, we should have found that it is only in certain definite proportions that they unite to give a solution without effect on the vegetable colouring matter, and we might sum up our experiments on the combination of these two substances as follows:—

Acid.		Base.		A salt.		Water.
Sulphuric acid, 98 parts by weight.	+	Sodic hydrate, 80 parts by weight.	=	Sodic sulphate, 142 parts by weight.	+	36 parts by weight.

And if we take crystals of sodic sulphate, and dissolve them in water, we can decompose them once more into sulphuric acid and sodic hydrate by the aid of galvanic electricity.

My aim in this experiment has been to impress upon you that a salt is a compound formed by the union of an acid and a base,

and one of Chevreul's greatest discoveries was that in tallow—the fat of oxen or sheep—you had a salt of organic origin, from which by decomposing the tallow with heated steam, you could obtain the sweet viscous liquid "glycerine," which played the part of base in the compound, and two acidulous compounds—one a lustrous white wax, called stearic acid, and the other an oil called oleic acid.

Now a salt can have its base replaced by another base. If I take two solutions, the one containing sulphate of copper, and the other chloride of iron, and add to each sodic hydrate, decomposition takes place in each case, sodic sulphate is left in solution, and the hydrates of copper and iron being insoluble in water, separate out as precipitates.

In the same way, if we add sodic hydrate to tallow, glycerine separates out, and two salts—sodic oleate and sodic stearate—are formed, a process which we call saponification, as the two sodium salts are "soaps."

It is not necessary to use tallow ; any vegetable or animal fat or oil will give reactions of a similar character, and it may be broadly stated that soap is formed by the action of sodic or potassic hydrate upon fats or oils which contain fatty acids.

Organic salt.   Base.   Salt.
Tallow + Sodic hydrate = Soap + Glycerine.

It is only potassic and sodic hydrates which can be used for ordinary soap-making, as the soaps formed by the combination of other metallic hydrates with the fatty acids are insoluble in water, and therefore useless for detergent purposes.

The soap formed by using sodic hydrate has the property of setting hard, and all the ordinary forms of washing-soap contain sodium as the base ; the potash soaps are far softer, and do not set, the soft soap used for scrubbing and cleansing in many manufacturing processes, and also a few toilet creams and shaving pastes, being of this character.

It would occupy far too much time, and would, moreover, be outside the scope of this lecture, to go into the details of the manufacturing methods by which soap is made on the large scale, and if I give a rough idea of the general processes employed, it will be sufficient for the purpose.

Carbonate of soda is first converted into hydrate by dissolving it in water, and then boiling with quicklime. Quicklime consists of calcic oxide, and this, when put into the vat containing the sodic carbonate in solution, combines with water, forming calcic hydrate, which then reacts with the sodic carbonate, forming calcic carbonate or chalk, which being insoluble sinks as a mud to the bottom of the vessel, whilst sodic hydrate remains in solution.

Calcic hydrate } = { Sodic hydrate
Sodic carbonate } = { Calcic carbonate.

Of late years the soap-boilers have to a great extent bought the sodic hydrate direct from the manufacturer, and so have avoided this operation.

The solution of sodic hydrate, called caustic ley, is made in different strengths, and tallow is first boiled with a weak ley, and as the conversion into soap proceeds, so stronger leys are used until the whole of the fatty matter has been saponified.

If a strong ley had been used at first, the soap as it formed being insoluble in strong alkalies would have coated the surface of the fat and prevented its complete conversion.

If at the end of the saponification process, the alkaline solution is sufficiently strong, the soap will on standing separate as a fluid layer on the surface of the spent ley, which contains the glycerine set free during the saponification, but in any case separation can be rapidly brought about by adding salt to the liquid, when the soap being insoluble in salt water or brine, separates out and is removed and placed in moulds to harden.

The block of soap so cast is then cut first into slabs, and then again into bars.

A soap made in this way with tallow or lard as the fatty matter, would be "white curd," whilst if yellow bar is required, rosin is added to the mixture of ley and soap after most of the fat has saponified.

When rosin is boiled with alkaline solutions, a compound is formed by the direct union of the resinous acids with the alkali, which strongly resembles ordinary soap, so that the yellow soap is really a mixture of fatty and rosin soap, and when the ingredients are of great purity, the product goes by the name of "Primrose" soap. Bar soaps so made on a large scale are, as a rule, the stock from which the various forms of toilet soap are

made by processes intended to render them more attractive for personal use, but generally the consumer gets far better value for his money, and far less injury to his skin, by using a good "white curd" or "Primrose" soap than by employing a high-priced toilet soap, whilst cheap toilet soaps, especially cheap transparent soaps, should be studiously avoided.

The demand made by consumers for cheap soaps, which in many cases are sold retail at prices considerably below the wholesale market price for a true soap, has given rise to the introduction of highly watered soaps, caused to set hard by the addition during manufacture of sodic sulphate, which enables the manufacturer to make a so-called soap often containing less than 20 per cent. of true soap.

Any person desiring to obtain the fullest particulars as to the manufacturing details of the soap trade, cannot do better than consult Dr. C. R. Alder Wright's admirable treatise upon the subject.

Having got our soap, the next point is to try and gain an idea of the way in which it acts as a detergent.

Supposing we are fortunate enough to have a sample of pure neutral soap, we find that on dissolving some of it in water, it undergoes a partial decomposition into alkali, and fatty acid, this action being called the hydrolysis of soap.

The small quantity of alkali so set free, attacks the fatty matter which glues the dirt to the skin, and by dissolving it loosens and enables the water to wash off the particles of dirt.

If this were the only action, however, soap would have no advantage over soda, a solution of which would equally well perform this part of the operation. As the soap decomposes and the alkali removes the grease and dirt, the fatty acid liberated simultaneously from the soap comes in contact with the newly-cleansed skin, and not only softens and smooths it, but also neutralises any trace of free alkali, and so prevents irritation and reddening of the cuticle.

These are probably the main actions by which soap cleanses, but other causes also play a subsidiary part. We know that a solution of soap causes a lather when agitated, this being due to the cohesive power given to the particles of which the liquid is built up by the presence of the soap, a phenomenon which also enables us to blow bubbles with the soap solution on account of the strength of the fine film of liquid, a property which is not found in water alone.

The power of cohesion which the soap solution possesses is in all probability an important factor in removing the particles of dirt from the skin at the moment that they are loosened by the action of the alkali. Prof. W. Stanley Jevons suggested yet a fourth way in which the soap solution might act ; when finely divided clay is suspended in water, the microscope reveals the fact that the minute particles are in rapid movement, and hence settle but slowly in the liquid. This movement he christened pedetic action, and he observed that the addition of soap or silicate of soda—often used in soap—to the liquid, enormously increased this agitation of the particles, which would tend to aid the breaking away of the dirt particles the moment they were set free.

Many soaps, even among the varieties intended for the toilet, contain a considerable excess of free alkali, which being greater than the liberated fatty acids can neutralise, cause most painful irritation of the skin, as is testified to by the smarting which annoys the chin after the use of certain shaving soaps ; and every lady knows that an alkaline soap, when used for washing the hair, renders it harsh and brittle, and destroys the gloss, but in both cases a rapid rinse with water, containing a few drops of vinegar, will neutralise the free alkali and prevent much of the mischief.

We have now dealt with our grease solvents and dirt looseners, but without the aid of water they would be useless ; and experience teaches us that the source of the water used for cleansing, has a great deal to do with its efficiency whether used with or without soap.

As the new-born rain-drops fall from the breaking clouds, they are practically pure water, containing at most traces of gaseous impurities which the mist has dissolved from the upper strata of air whilst journeying in the form of cloud, and where the rain is collected in the open country, it gives us the purest form of natural water, healthful to drink, because it is highly aerated, and free from all impurity, organic and inorganic, and delightful to wash in because of its softness and the ease with which the soap gives a lather.

In towns, however, a very different state of things exists, as the

rain in falling washes the air from a large proportion of the suspended organic matters inseparable from a crowded city, and also from the unburnt particles of carbon, which incomplete combustion allows to escape from our chimneys ; and charged with these, it still collects more dirt of various kinds from the roofs of our houses, and finally finds its way into our water-butts as the semi-putrid sludge which often causes the true-bred cockney to wonder "if this so-called purest form of natural water is so foul, what on earth must the other forms of water be like?" If in the country the rain water is collected and stored in suitable reservoirs, then we have the most perfect water that can be obtained for washing and cleansing purposes.

In some kinds of water collected under what we might consider ideal circumstances, we find "a something" which acts as a check upon the cleansing action of the soap.

In Attica, close to Athens, on the slopes of Mount Pentilicus, the Emperor Hadrian built some huge marble underground aqueducts to collect and lead the rain water down as a supply for Athens, the whole water-shed consisting of marble ; this mountain being justly celebrated as the source from which the finest statuary marble is obtained. Here, falling through the clear southern air on to a collecting ground formed of the material which all ages have considered the most suitable for baths and reservoirs, one would expect the water to be like the pure rain water, absolutely free from dissolved solid impurities, and one of the best waters of its kind for washing purposes ; yet not only does it waste a large amount of soap before a lather is obtained, but if we examine the channels through which it has for centuries flowed down to the valley, we find that it has formed a heavy deposit, which collecting unchecked through long ages, has all but choked up the once spacious passages. A piece of this deposit I have obtained through the kindness of a friend, and on analysis it proves to be :—

Calcic carbonate	...	...	...	96·81
Silica... ...	...	...	...	0·49
Organic matter	..	...	...	1·40
Moisture ...	...	...	...	1·30
				100·00

It is, in fact, a natural incrustation deposited by the water, and a similar action is seen in the formation of stalactites in many caverns, through the roof of which water charged with certain calcareous compounds has slowly found its way.

In the passage of the rain through the air small quantities of carbon dioxide or carbonic acid gas are dissolved from the atmosphere, whilst in slowly percolating through the surface soil on which it has fallen the water is brought in contact in the pores of the soil with far larger volumes of this gas, which is being continually generated there by the decomposing vegetation and other organic matter in a state of decay. Under these circumstances the water becomes highly charged with the gas, and sinks on through the ground until it comes in contact with some impermeable strata through which it cannot penetrate, and here it collects until a sufficient head of water has been formed for it to force its way along the strata to the surface of the earth, where it now appears as a spring, and during this passage through the earth it has dissolved everything that will yield to its own solvent action or to the activity of the carbon dioxide, which dissolved in water forms the weak carbonic acid, a compound which will dissolve many substances insoluble in the water itself, such as calcic carbonate, occurring in the soil as marble, limestone, or chalk, and also the carbonates of iron and magnesium. If we examine a spring water, we shall find that its dissolved impurities can be divided into two classes : for instance, taking the Kent water supplied at Greenwich, and obtained from deep wells in the chalk, we find its saline constituents in grains per gallon are :—

Calcic carbonate ...	...	...	...	16·30
Calcic sulphate	...	...	...	5·37
Magnesic sulphate	...	...	...	0·93
Magnesic nitrate ...	...	...	...	1·20
Sodic chloride	...	..	...	2·64
Sodic nitrate ...	...	...	...	1·21
Silica, alumina, &c.	...	...	...	0·97

And of these the calcic sulphate, magnesium, and sodium salts are dissolved by the solvent action of the water in the same way that sugar would be, whilst the chief impurity, calcic

carbonate, is scarcely at all soluble in the water itself, 16,000 parts of pure water only dissolving one part of the carbonate, but is readily soluble in the carbonic acid, in the water which converts it into soluble calcic bicarbonate.

In the household, waters are roughly classified as hard or soft waters, and the property of hardness manifests itself, as a rule, to the householder by its action upon soap, and also by the amount of "fur" which it causes in the kettle, these actions being due to calcic bicarbonate, calcic sulphate, and the magnesium salts present in it, all of which act upon soap and cause it to curd instead of forming a lather by converting the soluble sodic oleate and stearate into insoluble lime salts, whilst the bicarbonate by decomposing and depositing "chalk" causes the fur.

A more careful examination, however, reveals the fact that this property of hardness owes its origin to two different causes, for if we boil water until all the bicarbonate is broken up and the calcic carbonate deposited, the clear water left behind it is still hard, though to a far less extent, and will still decompose a certain proportion of soap. The hardness which can be got rid of by boiling is due to bicarbonate of lime, and sometimes also bicarbonate of magnesia, and is called "temporary hardness," whilst the hardness left after boiling the water is due to calcic sulphate and the soluble magnesium sulphate, chloride and nitrate, and is called "permanent hardness."

The relative hardness of waters is estimated by the amount of soap they will destroy, *i.e.* convert from the form of soluble sodic oleate and stearate into the condition of insoluble oleates and stearates of lime, and one grain of calcic carbonate or its equivalent in sulphate or salts of magnesia dissolved in a gallon of water, is said to equal 1° of hardness.

The sample of Kent water of which an analysis has been given, contains 23·6 grains of these salts, and would be said to have nearly 24° hardness, 7·5 of which would be permanent and 16·3 temporary.

When it is considered that 1° of hardness in water will waste 10 grains of soap per gallon of water used, we become aware of the economic importance of the kind of water employed in the household, a gallon of the Kent water, for instance, using up 236 grains or nearly half an ounce of soap before any becomes available to form a lather and exert a cleansing action upon the skin.

Glasgow used to have a hard water service, and when this was discontinued and the soft Loch Katrine water was supplied in its place, it made a difference of several thousands a year in the money expended in soap.

From these facts it is manifest that a soft water supply is an important factor in cheapening our cleansing processes, a pure rain water being the best attainable, whilst surface and river water are as a rule softer than spring water.

I have now discussed the chemistry of cleaning as fully as the time at my disposal will permit, and I hope the facts I have brought before you will have quickened your interest in soap, soda, and water, and will have helped to impress upon you that without proper processes of cleansing, the health of each unit, and therefore the prosperity of the masses, must suffer deterioration.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE following pass list for the degree of Doctor of Science of London University has been issued :—Experimental Physics : Mr. Edwin Henry Barton. Chemistry : Mr. Bevan Lean, Mr. Thomas Kirke Rose, Mr. Arthur Landauer Stern. Botany : Miss Margaret Jane Benson. Zoology : Mr. Arthur Willey.

HER MAJESTY'S Commissioners for the Exhibition of 1851 have made the following appointments to science research scholarships for the year 1894, on the recommendation of the authorities of the respective Universities and Colleges. The scholarships are of the value of £150 a year, and are tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country :—Scholar nominated by the University of Edinburgh, John Carruthers Beattie ; by the Univer-

sity of Glasgow, James Robert Erskine-Murray ; by the University of Aberdeen, William Brown Davidson ; by University College, Bristol, Reginald Charles Clinker ; by Yorkshire College, Leeds, Frankland Dent ; by University College, Liverpool, Alfred James Ewart ; by University College, London, David King Morris ; by Owens College, Manchester, Julius Frith ; by Durham College of Science, Newcastle-on-Tyne, Robert Beattie ; by University College, Nottingham, William Beckit Burnie ; by Queen's College, Galway, John Alexander M'Clelland ; by the University of Toronto, Frank Boteler Kenrick ; by Dalhousie University, Halifax, Nova Scotia, Frederick James Alexander M'Kittrick.

THE President and Council of the Royal Society have, upon the recommendation of the Joule Studentship Committee, elected Mr. J. D. Chorlton, of the Owens College, to the first Joule Studentship. This studentship was founded for the purpose of enabling students to carry on certain researches on lines laid down by Dr. Joule, more especially with the view of determining the constants of some of the instruments employed by him, which his representatives can place at the student's disposal.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 31.—"The Root of *Lyginodendron Oldhamium,* Will." By Dr. W. C. Williamson, F.R.S., and Dr. D. H. Scott.

During a re-investigation of the structure of *Lyginodendron,*[1] the results of which the authors hope to lay before the Royal Society on a future occasion, an important fact has come to light, which they place on record without delay.

A carboniferous fossil, with the structure perfectly preserved, has been described in previous memoirs, under the name of *Kaloxylon Hookeri,* Will.[2] The authors have now established the fact that *Kaloxylon* was not an independent plant, but was the root of *Lyginodendron Oldhamium.*

Specimens, presenting in every respect the typical *Kaloxylon* structure, have been found in actual continuity with the stem of *Lyginodendron,* arising from it as lateral appendages. Their structure and mode of origin prove that they were adventitious roots. These organs branched freely, and the authors have found roots and rootlets of all sizes, and at all stages of development.

This discovery enables a complete account to be given of the vegetative organs of *Lyginodendron,* as they are now fully acquainted with the structure, not only of the stem and foliage, but also of the adventitious roots.

June 14.—"On a Method for determining the Thermal Conductivity of Metals, with Applications to Copper, Silver, Gold, and Platinum." By James H. Gray.

The object of this investigation was to obtain a method for determining thermal conductivities of metals, which would not require either elaborate preparations or large quantities of the substances to be tested, and by means of which a test could be made in a few hours.

The essence of the method is to keep one end of a given length of the wire at a constant known temperature, and to measure the rise of temperature of the other end of the wire every minute. If proper precautions be taken to prevent loss by radiation from the sides, the data are obtained for calculating the thermal conductivity.

The wire to be tested is soldered at one end into the bottom of a copper box. The diameters found most convenient were from 2 to 4 mm., the lengths from 4 to 8 cm.

The box is filled with water and supported at its middle by being fitted into an asbestos-lined wooden screen, 24 × 24 cm. 3 mm. length of the other end of the wire is soldered into a solid copper ball, diameter 5·5 cm. In the ball a hole 3 cm. deep is made, so as to admit the bulb and part of the stem of a small and very sensitive thermometer. This thermometer is graduated from 5° C. to 20° C., and can easily be read to within one-fortieth of one degree. The bulb is surrounded by water.

[1] *Cf.* Williamson, "On the Organisation of the Fossil Plants of the Coal Measures," Part IV. *Phil. Trans.* 1873, p. 377 ; Part XVII. *Phil. Trans.* 1890, B. p. 89.
[2] *Cf.* "On the Organisation of the Fossil Plants of the Coal Measures," Part VII. *Phil. Trans.* 1876, Part 1, p. 1 ; Part XIII. *Phil. Trans.* 1887, B. p. 289.

All the probable errors are practically tested by using different lengths or diameters of the wire, and the results obtained in the present investigation indicate that the errors have been eliminated.

In order to make a complete test of a metal it is only necessary to take a wire of 5 or 6 cm. length and solder it firmly, the one end into the bottom of the heating box, the other into the calorimeter ball. The water in the heating box is kept boiling briskly, and readings are taken every half-minute from the thermometer in the ball. These readings are then put upon a curve as ordinates, with the time in minutes as abscissæ. From this curve the rise of temperature per unit time can then be accurately read off, and, the thermal capacity of the ball being already determined, the flow of heat per unit time is obtained.

At the beginning of the experiment the ball is cooled to about 6° or 7° C. below the temperature of the air, and the rise for equal temperatures above and below that of the air taken, the radiation being thus eliminated.

The metal which was chiefly used for the exhaustive tests of the method was copper wire, of diameter 0·21 cm., density 8·85, volume specific (electrical) resistance at about 13° C. 1834 in absolute units.

It must be noted that the found values are the means of the conductivities corresponding to the temperatures at the ends of the wire. When compared with the values obtained by other experimenters, the results of the latter must be taken for the mean of 97° C. and 10° C., that is, 53° C.

For this temperature Ångström gives 0·9208.

Several qualities of copper were tested, as well as pure gold, silver, and platinum, kindly lent for investigation by Messrs. Johnson, Matthey, and Co.

The values are given below :—

Mean Conductivity between Temperatures 10° C. *and* 97° C.

					Thermal conductivity in C.G.S. units.	Diameter.
Copper, Specimen	1		...	...	0·9594	2·00 mm.
,,	,,	2	...	..	0·88838	2·11 ,,
,,	,,	3	...	...	0·8612	3·09 ,,
,,	,,	4 (very impure)			0·3497	2·04 ,,
,,	,,	5	,,		0·3198	2·04 ,,
Silver	(pure)	...	...	...	0·9628	2·02 ,,
Gold	,,	...	...	...	0·7464	2·00 ,,
Platinum	,,	...	...	...	0·1861	2·00 ,,

"Flame Spectra at High Temperatures. Part III. The Spectroscopic Phenomena and Thermo-Chemistry of the Bessemer Process." By Prof. W. N. Hartley, F.R.S.

The flame issuing from the mouth of a Bessemer converter was first investigated by Sir Henry Roscoe[1] in 1863 ; by Lielegg,[2] and by Marshall Watts in 1867 ;[3] by Tunner,[4] J. M. Silliman, Rowan,[5] Von Lichtenfels,[6] Spear Parker,[7] Kupelwieser,[8] Brunner,[9] and Wedding in 1868 ;[10] also by A. Greiner in 1874.[11]

Up to the present time the precise nature of the spectrum, the cause of its production, its sudden disappearance when decarburisation of the metal takes place, and the connection between the decarburisation of the metal and the extinction of the spectrum have not been satisfactorily explained. According to Roscoe, Lielegg, Kupelwieser, and Spear Parker, the spectrum is characterised by bands of carbon or of carbon monoxide, which disappear when all carbon is burnt out of the metal.

On the other hand, the investigations of Simmler,[12] Brunner, Von Lichtenfels, and Wedding, the spectrum is not due to

[1] Literary and Phil. Soc., Manchester, *Proc.,* vol. 3, p. 57, and *Phil. Mag.,* vol. 34, p. 437.
[2] *Sitzungsberichte Kaiserl. Akademie der Wissenschaften,* Wien, vol. 56, Part ii.
[3] *Phil. Mag.,* vol. 34, p. 437.
[4] *Dingler's Polytech. J.,* vol. 178, p. 465.
[5] *Phil. Mag.,* vol. 41, p. 1.
[6] *Dingler's Polytech. J.,* vol. 191, p. 213.
[7] *Chem. News,* vol. 23, p. 25.
[8] *Oesterreichische Zeitschr. fur Berg- und Hütten-Wesen,* No. 8, p. 59, 1868.
[9] *Loc. cit.,* No. 29, p. 227, 1868.
[10] *Zeitschrift für das Berg Hütten- und Salinen-Wesen,* vol. 27, p. 117, 1869.
[11] *Revue Universelle,* vol. 35, p. 623.
[12] *Zeitschr. fur Analytische Chemie,* 1862.

carbon (Roscoe) or to carbon monoxide (Lielegg and Kupelwieser), but to manganese and other elements in the pig-iron.

The very careful examination of these spectra by Watts and his comparison of them with that of the Bessemer flame led to the conclusion that it was not the spectrum of carbon in any form nor of manganese, but that of manganic oxide.

Owing to the courtesy of Mr. F. W. Webb, the engineer of the Locomotive Department of the London and North-Western Railway, and of Mr. E. P. Martin, the manager of the Dowlais Ironworks, observations have been made at Crewe and at Dowlais during the past year. Ninety spectra were photographed, about fifty of which were available for study.

Ninety-two lines were identified with lines in the solar spectrum, with lines in Kayser and Runge's map of the arc spectrum of iron, and in spectra from steel and ferric oxide heated in the oxyhydrogen flame.

The Constitution of the Bessemer Spectrum.

The spectrum is a complex one which exhibits differences in constitution during different periods of the "blow," and even during different intervals in the same period. As originally observed by Watts, the spectrum differs in different works, the difference being due to temperature and to the composition of the metal blown.

During the first period.
{ The lines of the alkali metals, sodium, potassium and lithium, are seen unreversed on a bright continuous spectrum caused by carbon monoxide. The C line of hydrogen and apparently the F line were seen reversed during a snowstorm.

During the second period. The "boil."
{ Bands of manganese are prominent, overlying the continuous spectrum of carbon monoxide. There are lines of carbon monoxide, manganese, and iron, also those of the alkali metals.

During the third period. The "fining stage."
{ The spectrum is the same as the foregoing, but the lines of iron are not so strong and not quite so well defined. Some of the short lines disappear. The lines of the alkali metals are visible.

The alkali metals do not show themselves in the Bessemer flame until a layer of slag has been formed, and the temperature has risen sufficiently high for these basic constituents to be vapourised. At the temperature of the "boil" or second period, both metallic manganese and iron are freely vapourised in a current of carbon monoxide, which, in a highly heated state, rushes out of the bath of molten metal. The evidence of this is the large number of bands of manganese and lines of iron in the spectrum.

When the metal blown contains but little manganese, the manganese spectrum in the flame does not arise from that substance being contained in the bath of metal, it must be vapourised from the slag. That this is so has been proved by photographs of the spectrum from samples of slag obtained from the Crewe works. This explains the fact observed by Brunner, namely, that when a converter is being heated with coke after it has been used, but not relined, the spectra of the Bessemer flame makes its appearance; manifestly it comes from the adhering slag.

The luminosity of the flame during the "boil" is due, not merely to the combustion of highly heated carbonic oxide, but also to the presence of the vapours of iron and manganese in the gas.

The disappearance of the manganese spectrum at the end of the "fining stage," or third period, is primarily due to a reduction in the quantity of heated carbon monoxide escaping from the converter, which arises from the diminished quantity of carbon in the metal. When the last traces of carbon are gone, so that air may escape through the metal, the blast instantly oxidises any manganese, either in the metal or in the atmosphere of the converter, and, furthermore, oxidises some of the iron. The temperature must then fall with great rapidity.

The entire spectroscopic phenomena of the "blow" are undoubtedly determined by the chemical composition of the molten iron, and of the gases and metallic vapours within the converter, the temperature of the metal and that of the issuing gases.

The Temperature of the Bessemer Flame.

The probable temperature of the Bessemer flame at the finish is that produced by the combustion in cold air of carbonic

oxide heated to about 1580° C., that is to say, to the temperature which, according to Le Chatelier (*Comptes Rendus*, vol. cxiv. p. 670) is that of the bath of molten metal from which the gas has proceeded. The bath of metal acts simultaneously as a means of heating the blast, producing the gas, and as a furnace, on the regenerative principle, which heats the gas prior to its combustion. The heating effect is therefore cumulative. The temperature, as is well known, can easily rise too rapidly, and the metal has then to be cooled.

If we may judge by the lines and bands belonging to iron and manganese which have been measured in photographed spectra of the Bessemer flame, the temperature must nearly approach that of the oxyhydrogen flame, and may easily attain the melting point of platinum, namely, 1775° C. (Violle).

From thermo-chemical data the heat evolved during the "blow" has been calculated, but the specific heats of cast iron, slag, carbon monoxide, and nitrogen are unknown at temperatures between 1200° C. and 2000° C. If we allow for 50 per cent. of heat developed at high temperatures being lost by radiation or otherwise, then the estimated temperature of the metal in the converter is more than 1900° C.

Le Chatelier (*Comptes Rendus*, vol. cxiv. p. 670) found the steel in the ladle of a Robert converter to be at 1640° C. Reasons are adduced for believing that it was hotter than this at the highest temperature of the "blow."

The Technical Aspect of this Investigation.

The complete termination of the "fining stage" is clearly indicated, but there is no indication by the flame of the composition of the metal within the converter at any previous stage. As the progress of the "blow" is governed by the composition of the metal and its temperature in the converter, and as these cannot be controlled with perfect exactitude during each "blow," it follows that the practice of complete decarburisation [1] is the best course to pursue, the required amount of carbon and manganese being added subsequently in the forms of grey iron, spiegel, or ferro-manganese.

Mathematical Society, June 14.—Mr. A. B. Kempe, F.R.S., President, in the chair.—Abstracts of the following communications were read by the secretary (Mr. R. Tucker).— The solutions of $\sinh\left(\lambda\frac{d}{dx}\right)y = f(x)$, $\cosh\left(\lambda\frac{d}{dx}\right)y = f(x)$, λ a constant, by Mr. F. H. Jackson.—A theorem in inequalities, by Mr. A. R. Johnson. This was a theorem which in a natural way fills up the gap between the A.M. and the G.M. of a number of positive quantities.—Some properties of a circle, by Mr. R. Tucker.—Note on four special circles of inversion of a system of "generalised Brocard" circles of a plane triangle, by Mr. J. Griffiths.—On the order of the eliminant of two or more equations, by Dr. R. Lachlan. In analytical work it is often important to know what will be the order of the eliminant of two equations containing several variables when one of them is eliminated. This question can in general be answered even when it is not easy to perform the elimination. A discussion of the question is given in Serret's "Cours d'Algèbre Supérieure," and is said to be due to Minding. But a simpler method would seem to be arrived at by geometrical considerations. Thus, suppose that it is required to find the order of the eliminant in y when x is eliminated from any two equations,

$$f_1(x, y) = 0 \text{ and } f_2(x, y) = 0.$$

Let a third variable, z, be introduced, so that the equations may be written in the homogeneous forms,

$$\phi_1(x, y, z) = 0 \text{ and } \phi_2(x, y, z) = 0,$$

and let the degrees of these equations be m and n. When these equations are regarded as representing curves, the eliminant will represent the lines connecting the point $y = 0$, $z = 0$ to the points common to the two curves. Hence, the order of the eliminant will be at most mn, because the curves will intersect in that number of points. But a little consideration will show that it will not in general be necessary to take into account the points common to the two curves which lie on the lines $y = 0$, $z = 0$. Similarly, if it is required to eliminate x and y from three equations containing x, y, and z, let a fourth variable, w, be introduced, so as to make the equations homogeneous. Then

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[1] The words "carburising" and "decarburising" are to be preferred to "carbonising" and "decarbonising" when applied to metals, because these expressions were those originally used in the older works on metallurgy, and they avoid confusion with the other signification of the word "carbonising."

the order of the eliminant will be the number of common points of the surfaces, less the number of common points which lie in the two planes $z = 0$, $w = 0$. In the paper several examples are considered. It will suffice to mention here the case which led to these investigations. Consider two equations of the form

$$\frac{a_1 x_1}{a_1 + \theta} + \frac{a_2 x_2}{a_2 + \theta} + \frac{a_3 x_3}{a_3 + \theta} = 1.$$

These equations may be written in the homogeneous form

$$\frac{a_1 x_1 \phi}{a_1 \psi + \theta} + \frac{a_2 x_2 \phi}{a_2 \psi + \theta} + \frac{a_3 x_3 \phi}{a_3 \psi + \theta} = 1,$$

and thus represent curves of the third order. But the curves have evidently three common points on the line $\phi = 0$; and a common node (with different tangents) at the point $\theta = 0$, $\psi = 0$. Hence the degree of the eliminant of the given equations is

$$9 - 3 - 4 = 2.$$

More generally, the eliminant of two equations of the form

$$u_n + u_{n-1} + \ldots + u_0 = 0,$$
$$v_m + v_{m-1} + \ldots + v_0 = 0,$$

where u_i and v_i are homogeneous expressions of the ith degree in

$$\frac{x_1}{a_1 + \theta}, \quad \frac{x_2}{a_2 + \theta}, \ldots, \quad \frac{x_r}{a_r + \theta},$$

is shown to be of degree $(r - 1)mn$ in the variables $x_1, x_2, \ldots x_r$. —Solvable cases of the motion of a top or gyrostat, by Prof. A. G. Greenhill, F.R.S. When the sum of the parameters of the two elliptic integrals of the third kind, whose poles correspond to the highest and lowest position of the axis of the top, is an aliquot part of the associated elliptic function periods of the form $K + fK'i$, where f is a proper fraction, then Abel's theory of Pseudo-Elliptic Integrals can be utilised to construct an algebraical solution of the motion, provided that in the general case a secular term pt is associated with the azimuth ψ of the axis. Denoting by θ the angle between the axis of the top and its highest position, and supposing θ to oscillate between a and β, $a > \theta > \beta$, then the dynamical equations to be satisfied are of the form

$$\tfrac{1}{2} A \left(\frac{d\theta}{dt}\right)^2 + \tfrac{1}{2} A \sin^2 \theta \left(\frac{d\psi}{dt}\right)^2 = W gh (d - \cos \theta),$$

$$A \sin^2 \theta \frac{d\psi}{dt} + Cr \cos \theta = G;$$

equivalent to, with $n^2 = W gh/A$,

$$\sin \theta \frac{d\theta}{dt} = n \sqrt{2} \sqrt{(\cosh \gamma - \cos \theta \cdot \cos \beta - \cos \theta \cdot \cos \theta - \cos a)},$$

$$\sin^2 \theta \frac{d\psi}{d\theta} = \frac{\dfrac{G - Cr \cos \theta}{\sqrt{(2 A W gh)}}}{\sqrt{(\cosh \gamma - \cos \theta \cdot \cos \beta - \cos \theta \cdot \cos \theta - \cos a)}};$$

and it is found that the constants in the problem can be expressed in terms of two arbitrary constants m and c.

In the simplest case, $f = \tfrac{1}{2}$, the motion of the axis, or of a fixed point on it, will be given by the equation

$$\sin^2 \theta e^{2i(\psi - pt)i} = (\cos \theta - D) \sqrt{(\cosh \gamma - \cos \theta \cdot \cos \beta - \cos \theta)}$$
$$+ i(E \cos \theta - F) \sqrt{(\cos \theta - \cos a)},$$

where

$$\cos a = \frac{m^2 - 1 - c - c^2}{\sqrt{M}},$$

$$\cos \beta = \frac{m^2 - 1 - c + c^2}{\sqrt{M}},$$

$$\cosh \gamma = \frac{m^2 + 1 + 3c + c^2}{\sqrt{M}},$$

$$M = (m^2 - 1 + c + c^2)^2 + 8(m + 1)(c + c^2).$$

$$D = \frac{3m^2 + 4m + 1 - c - c^2}{\sqrt{M}}, \quad E = \frac{(2m + 1)\sqrt{2}}{\sqrt[4]{M}},$$

$$F = \frac{2m^3 + 3m^2 + 2(1 + c + c^2)m + 1 + 3c + 3c^2}{M^{\frac{3}{4}}},$$

$$\frac{p}{n} = \frac{2m + 1}{2\sqrt[4]{M}}, \quad \frac{G^2}{2 A W gh} = \frac{2m^2}{\sqrt{M}}, \quad \frac{C^2 r^2}{2 A W gh}$$

$$= 2 \frac{m^6 - 2(1 - a)m^4 + (1 - 6a + a^2)m^2 - 4(a - a^2)m + 4a^2}{M^{\frac{3}{2}}}$$

where $a = c + c^2$.

The modulus k of the associated elliptic functions is given by $k = c/(1 + c)$, so that the period of the axis between its highest and lowest position is $\dfrac{\sqrt[4]{M}}{(1 + c)\sqrt{2}}$ times the period when the body makes plane oscillations, swinging through an angle $4 \sin^{-1} c/(1 + c)$.

By putting $m = -\tfrac{1}{2}$, the secular term pt is made to disappear, and the path of a point on the axis of the top is a closed curve with four branches; this curve has four cusps if $c = \tfrac{1}{2}$, and it has four loops if $c > \tfrac{1}{2}$.

The term Cr can be made to disappear by determining a in terms of m by the solution of a quadratic equation, and the motion is that of a spherical pendulum; but it is not possible now to make p vanish. In the next case of $f = \tfrac{1}{3}$ the motion of the axis is given by an equation of the form

$$\sin^3 \theta e^{3i(\psi - pt)i} =$$
$$(\cos^2 \theta - D \cos \theta + D') \sqrt{(\cosh \gamma - \cos \theta \cdot \cos \theta - \cos a)}.$$
$$+ i(E \cos^2 \theta - F \cos \theta + F') \sqrt{(\cos \beta - \cos \theta)}$$

and

$$\cos a = \frac{m^2 - 1 + 4c - 5c^3 + 0 + c^4}{\sqrt{M}},$$

$$\cos \beta = \frac{m^2 - 1 + 4c - 5c^2 + 4c^3 - c^4}{\sqrt{M}},$$

$$\cosh \gamma = \frac{m^2 + 1 + 0 - 5c^2 + 4c^3 - c^4}{\sqrt{M}},$$

$$M = (m^2 - 1 + 8c - 15c^2 + 8c^3 - c^4)^2$$
$$+ 8(1 - c)^2 (2c - c^2) (1 - 2c) (m + 1 - 3c + c^2),$$

$$k^2 = \frac{2c^3 - c^4}{(1 - c)^3 (1 + c)}, \quad \frac{p}{n} = \frac{3m + (1 - 2c)(2 - c)}{3\sqrt[4]{M}}$$

$$E = \frac{3m + (1 - 2c)(2 - c)}{\sqrt[4]{M}} \sqrt{2} \ldots$$

D, D', E, E' being readily found by verification. In this case the secular term pt is destroyed by taking $m = -\tfrac{1}{3}(1 - 2c)(2 - c)$, and a point in the axis now describes a curve with six loops. The case of $f = \tfrac{2}{3}$ can similarly be made to give a curve with three loops, the general state of motion being given by an equation of the form

$$\sin^3 \theta e^{3i(\psi - pt)i} = (\cos^2 \theta - D \cos \theta + D')$$
$$\sqrt{(\cos \beta - \cos \theta \cdot \cos \theta - \cos a)}$$
$$+ i(E \cos^2 \theta - F \cos \theta + F') \sqrt{(\cosh \gamma - \cos \theta)}.$$

A similar procedure will serve for

$$f = \frac{1}{4}, \quad \frac{3}{4}, \quad \frac{1, 2, 3, 4}{5}, \&c.;$$

the results are of rapidly increasing complexity, but the constants D, E, ... are readily determined when p is known, E being the simple multiple $\mu \sqrt{2}$ of p/n, while

$$\frac{p}{n} = \frac{\mu m + \rho}{\mu \sqrt[4]{M}},$$

where

$$\tfrac{1}{2} \int \frac{\rho(Pu - Pv) + \mu P'v}{Pu - Pv} du$$

is the pseudo-elliptic integral corresponding to a parameter v, which is a μth part of a period. The Rev. F. J. Smith, F.R.S., of Oxford, has constructed an apparatus by which the preceding theory can be tested, and the agreement between the predicted and experimental results is very satisfactory.—Impromptu communications were made by Dr. J. Larmor, F.R.S. (on the wave surface), and Dr. M. J. M. Hill, F.R.S. (on Monge's solution of a differential equation).—At the special meeting, held on the same evening, for considering certain resolutions relating to the incorporation of the Society under the Companies Act 1867, authority was given to the Council to carry out the incorporation.

PARIS.

Academy of Sciences, July 2.—M. Lœwy in the chair.— Researches on phenylhydrazine. Action of oxygen and of water; formation of salts, by M. Berthelot. Oxygen reacts on a solution of phenylhydrazine hydrochloride, giving off a volume of nitrogen equal to that of the oxygen absorbed, and yielding an uncrystallisable oily compound answering to the reactions of diphenylhydrazine. Pure anhydrous phenylhydrazine heated at 100° with oxygen in sealed vessels yields about half as much

again nitrogen. Phenylhydrazine forms a crystalline hydrate melting at 24°·1 and having the composition $2C_6H_8N_2 . H_2O$. Thermal data are given for the formation of the hydrate and some of the salts of this base.—Impurities of commercial aluminium, by M. Henri Moissan.—Preparation of a crystalline aluminium carbide, by M. Henri Moissan. A carbide of aluminium forming fine yellow transparent crystals is described. It has the composition C_3Al_4, and slowly decomposes water at the ordinary temperature with the formation of methane.—On the place of production and the mechanism of the murmurings in tubes through which pass currents of air, by M. A. Chauveau. The murmurings are the effect of the transmission of sounds originated by vibrating fluid veins which form at the orifices or at the entrance of dilatations of the tubes. —The use of the potato for feeding cattle—production of meat, by M. Aimé Girard. The results of an extended investigation show that the potato is much superior to beetroot as a food-material for cattle and sheep, and can be used economically with remarkable results as a normal meat-producing forage.—A note by M. Armand Gautier accompanying the presentation of his work, "The Chemistry of the Living Cell."—On the geographical distribution of Cyrtandreæ, by M. E. Drake del Castillo.—On the algebraical integration of differential linear equations, by M. Paul Painlevé.—On a class of polynomials decomposable into linear factors. An extract from a letter to M. Appell, by M. Moutard.—Experimental researches on the conditions of employment and forms of boats used for haulage, by M. J. B. de Mas.—On the elasticity of torsion of an oscillating wire, by MM. G. Berson and H. Bouasse.—On the calorific radiations comprised in the luminous part of the spectrum, by M. Aymonnet.—Reception of sounds, by M. Henri Gilbault.—On enharmonic gamuts, by M. A. de Berthe. —On an application of cathode rays to the study of variable magnetic fields, by M. Albert Hess. An apparatus is employed in which the cathode rays are generated in a Geissler tube and received on a photographic film. Being given that deviations of the rays are due to modifications of the state of tension of the ether under the influence of the magnetic field, the cathode rays form an index without inertia capable of registering the variations of intensity of a magnetic field with a speed only limited by the sensitiveness of the photographic film.— Determination of the form of periodic currents as a function of the time by means of the electrochemical inscription method, by M. P. Janet.—A transformer of monophase into triphase currents, by M. Désiré Korda.—Researches on the action of the acid molybdates of sodium and ammonium on the rotatory power of rhamnose, by M. D. Gernez. Small additions of molybdate determine a relatively great increase of the observed rotation. A maximum effect is produced by the addition of $\frac{6·75}{24}$ of the molecular weight. Greater quantities produce no further appreciable change. The maximum effect is produced by quantities of the molybdates equal to those found to give maximum effects in the cases of mannitol, sorbitol, and persitol.—On the change of sign of the rotatory power, by M. Albert Colson. The author concludes that, from the experimental evidence given, (1) there exist compounds having a rotatory power very variable with the temperature, even to the extent of changing sign, as in the case of isobutylamyl oxide; (2) in certain cases these great variations are caused by alterations in the state of chemical equilibrium.—On the line spectrum of sulphur and on its detection in metallic compounds, by M. A. de Gramont.—New researches on the bromo-boracites, by MM. G. Rousseau and H. Allaire. A description is given of the preparation and properties of compounds of magnesium, zinc, cadmium, manganese, cobalt, and nickel of the general type $6MO . 8B_2O_3 . MBr_2$.—Influence of pressure on the combination of hydrogen and selenium, by M. H. Pélabon. The dissociation theory indicates that the pressure should have no influence on the ratio of hydrogen to hydrogen selenide produced, as there is no alteration of volume in the reaction. The experimental numbers obtained sensibly agree with this conclusion, better as the temperature is higher. The augmentation of pressure increases very slightly the quantity of hydrogen selenide produced at a certain temperature, more as the temperature remains lower.—On a reaction of aldehydes. Differentiation of aldoses and ketoses. By MM. A. Villiers and M. Fayolle. Fuchsine decolourised by sulphurous acid may be used to discriminate between aldoses and ketoses, the former giving when

present in sufficient quantity the aldehyde reaction, though less intensely than ordinary aldehyde.—On the substitution of alcoholic radicals combined with carbon or with nitrogen, by M. C. Matignon. A claim for originality as against MM. Stohmann and Langbein.—Remarks on the preceding note, by M. Berthelot.—On piceine, a glucoside from the leaves of *Pinus picea*, by M. Tanret. The glucoside has been resolved into glucose and piceol, $C_8H_8O_2$. The latter substance is described as a monotomic phenol.—On the presence of hydrogen and ethylene in the residual nitrogen from blood, by M. L. de Saint-Martin.—Action of sulphuric acid on camphene, by MM. G. Bouchardat and J. Lafont. The products are (1) the mixed ether of borneol and inactive camphene; (2) borneol sulphuric acid; and (3) polymerides of camphene.—On the bromo-derivatives of tetrachlorethylene, by M. A. Besson.—On some new organo-metallic combinations, by M. G. Perier. Anhydrous aluminium chloride forms, with ketones and similar bodies, compounds of the type $R_2 . Al_2Cl_6$. This article demonstrates the existence of similar compounds with amines, amides, and their substitution products.—On the formation of succinic acid and glycerine in alcoholic fermentation, by M. J. Effront. —The influence of chlorides on nitrification, by MM. J. Crochetelle and J. Dumont.—A new case of commensalism: association of *Aspidosiphon* with coral polyps and a bivalve mollusc, by M. E. L. Bouvier.—Transformation of the aortic arches in the frog, by M. S. Jourdain.—On the respiration of leaves, by M. L. Maquenne.—The mechanism of movements incited in *Berberis*, by M. Gustave Chauveaud.— The "brûlure" of vine-leaves produced by *Exobasidium vitis*, by MM. Prillieux and Delacroix.—On a new disease of wheat caused by Chytridineæ, by M. A. Prunet.—"Brunissure" in Algeria, by M. F. Debray.—On the earthquake of Locrides (Greece) in April 1894, by M. Socrate A. Papavasiliore.— Potatoes as food for milch-cows, by M. Ch. Cornevin.—The vegetation of vines treated by submersion, by M. A. Muntz.— On the determination of the agricultural value of several natural phosphates, by M. G. Paturel.—Currents and winds on the coast of the Landes of Gascony, by M. Hautreux.

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